FEEDBACK REPORT

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1. Expert Meeting 27.11.2014

TenneT proposes a MV connection interface on 66kV. This has been challenged by the participants given the current planning and on the other hand has been recognized as a future step that would be beneficial to lower the costs for Offshore Wind. Enough competition from suppliers should be verified, including certainty on certifications for the necessary equipment. An interaction with the conditions for the tender by MinEZ for the "Kavels" is foreseen when this step is taken.

2. Expert Meeting 29.01.2015

Buying a WTG with 66kV end, means that manufacturers will have the responsibility to deliver the transformer and switchgear and therefore will have to qualify it as an 66kV WTG with increased market costs. DNV believes the OWF can have influence in these equipment without recertification and therefore keep transparency on added costs for a "66kV WTG". Participants are not sure whether this will be the case in practice.

Infield cable price (Eur/m) is expected to increase going from 33kV to 66kV, by values up to 50%. TKI have stated a 15% increase, but it is not known if this is a total price increase, or only material cost. It is expected that certified wet design cables can be purchased end of 2016, probably from a limited number of suppliers.

Good overview with regards to the 'maturity' of the supply chain is needed, especially if ordering is planned for beginning 2016 (including the associated cost risk). It is expected, that there will be cost increase for the first tender, which is not recognized at MinEA at this moment. Next to this, an increase in (perceived) risk due to the higher voltage is expected which could have an effect on bankability.

Possibly distinctions should be made between the effect of stepping to 66kV as a current standard and as a future standard, including the supply chain.

While there is a big need for a better cost insight, nobody is able to share the needed costs and it should be checked if there are possibilities to make these available.

Certification of the wet design cable is seen by the OWF as critical for risk assessment of the tender. Issue also identified by Carbon Trust organisation; currently subsidising three manufacturers with the certification process.

With respect to the reactive power compensation of the array cabling, a proposal was raised in the discussion to use a predesign of a specific "Kavel" at Borssele and verify the differences between 33kV and 66kV solutions.

Shouldn't the WTG suppliers be more active involved in this position paper? Given the limited number this could be checked. And see if there will be a big restriction on available suppliers for mainly the first tender.

3. Expert Meeting 18.03.2015

Summary of concerns based on feedback during the Expert Meeting

- Concerns with respect to the availability and lack of competition of wind turbine and cable suppliers that can provide 66 kV best and final offers (BAFO) to bidding parties. This including guarantees which are comparable to those currently given at 33 kV.
- The 30% reduction of cable length taken into account as savings due to switching to 66 kV. Does this hold in case of specific layout constraints or redundancy schemes?
- There is a request for ranges in the LCoE impact numbers and a quantitative indication for the currently given qualitative trends.
- There may be Installation specific constraints for 66 KV and availability, with a potential impact on cost of installation vessels.

Feedback from the meeting attendees:

We don't see certification of the wind turbine to be an issue. At least three wind turbine suppliers are capable of providing a bid with the 66kV application".

We would like to express our worry about standardisation. We see other developments in the market: Dong for example makes smaller substations which decreases the costs. Standardisation could stop better solutions.

9 Months before bid closure all technical details should be ready: do we expect the supply chain at that point to be technically ready and able to provide a bid including binding price and sufficient guarantees?

With regards to costs, the present cost estimation of TenneT might be too optimistic and highlighting the advantages more than the challenges and risks in applying 66kV on the short term. The presented table with qualitative aspects as presented should be more elaborated in quantitative ranges.

With my lay-out I don't come to a 30% cable reduction based on their numbers. And not to 1.7% reduction in cost. Therefore this decision could drive up the price for development of wind farms.

There could be technical issues during installation of a 66 kV cable: vessels with drums will also be a limiting factor. This may increase installation costs due to a limited market.

The implications of 66kV in terms of risks in installation and repair should be looked at in more detail.. Including the difference in installation due to a bigger bending radius, the need for different ships and their availability, both during installation and (unscheduled) repair.

4. Expert Meeting 15&16.04.2015

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.

5. Expert Meeting 12&13.05.2015

[Notification]

The connection voltage level of the inter-array systems to the TenneT offshore transformer platform will be standardised at 66 kV for all five platforms to be realised by TenneT up to 2023.

Followed by a short discussion on request for reducing risk for OWF if cable certification is not ready yet. EZ is not planning on taking away or reducing this risk for the market.

6. TenneT stakeholder consultation website March

We acknowledge that 66kV could lead to costs savings on the long run, but on short term might lead to costs increase partly caused by scarcity of dedicated and certified 66kV components and equipment. This should be looked at in more detail for Borssele in specific and for the given time slot of the first tender closing in 2016.
The most critical aspect will be the availability of dedicated components (switchgear, turbines, cables, etc.) and equipment (e.g. vessels) and their certification. The timelines for all these components should be totally clear in advance. For this our advice is to work together with (turbine) manufacturers in order to make sure these timelines can be met. There should be no exclusion of the most important turbine manufacturers due to this choice. Rule of thumb is that for a good procurement process the competition of at least three to four parties is needed. Market limitation is likely to lead to a price increase, or lead to an unfeasible tender and, as such not in accordance with the goal of cost reduction.
Furthermore it should be studied more into depth on the implications of 66kV in terms of risks in installation and repair. Including the difference in installation due to a bigger bending radius, the need for different ships and their availability, both during installation and (unscheduled) repair.
The present study states that installation costs are the same because the weight of the cable is the same. Is the bending radius also considered? And the availability of ships and personnel?

The present cost estimation of TenneT might be too optimistic and highlighting the advantages more than the challenges and risks in applying 66kV on the short term. The presented table with qualitative aspects as presented should be more elaborated in quantitative ranges. Potential cost-increases should be part of the cost calculations made by ECN for the ministry.
Developers appear to benefit from most of the 1% LCoE cost reduction suggested in the TenneT paper - but this is likely to be priced in the competitive tender bids for the site, thus leading to Society benefits. There should be a provision in the Dutch regulations to protect developers having to apply 'imposed' new 66kV technology in some way – i.e. if developers facilitate the cost saving to Society then there should be some protection against new technology risk. For example up to a certain amount of developer's lost energy costs reclaimable if failure in operation can be attributed to use of 66kV. To determine that amount we need a better measure or proposal, as is also quoted by DNV/GL in their report: "Common practice in developing any large electrical installation is to conduct electrical concept studies during the early stages of project development, including a risk assessment of the components. By undertaking such studies the benefits and drawbacks can be quantified clearly. Such studies are outside the scope of this document although such studies are expected to clarify the decision with confidence, the use or not of 66 kV as an array system voltage."

The documents state that there are/will be sufficient suppliers for 66 kV cables and 66 kV wind turbines which can deliver at acceptable prices . What's the base of this statement. Has it been checked with suppliers? And has the timeline for the first tender been checked with these suppliers?

The documents use 15% CAPEX reduction. Does this stand for the entire electrical infrastructure?

Please specify which total investment was taken into account for cables, transformers and switchgear, in order to justify the 15% reduction with respect to all the different elements.

We agree with the impact on costs: decrease in costs of required infield cable length; cable installation work; amount of J-tubes; structural work; offshore works; electrical losses. Using 66kV will effectively reduce the number of necessary array cables entering the platform by a factor two. This reduces the risk of cable damages, as installing a large number of 33kV cable and several transmission cables entering into one 700MW platform will result in a significant risk of damaging cables when working in the congested area close to the platform.

We agree with the impact on costs: increase in costs of switch gear; transformer; cable supply per meter; impact of cable failure. If TenneT decides to go for standardized design employing 66kV for the complete portfolio of 3.5GW, it will be a significant signal to the marked, which we know suppliers would welcome. We believe this will facilitate further development and optimisation as well as competition in the supply chain.
Re. switchgear:
Alstom, Siemens, Schneider and ABB all have switchgear that can be used for the offshore substation. Fewer bays needed for 66kV result in same total costs. So no increase here.
Both Siemens and Schneider are developing compact and more cost-effective switchgear for turbines. Again, a volume of potentially 3.5GW would perhaps make it interesting for others to follow, and trigger competition.

Cables certification: We don't believe that cables as such need certification. Cables are type tested according to IEC standards and at 66kV maybe even type tested together with accessories.
Moreover, it is known in the industry and substantiated via an ongoing Carbon Trust OWA project in the UK that several major well known cable manufacturers are developing 66kV cables for offshore wind application, hence there's no concerns that 66kV cables will not be available, and that type tests and if needed certification will be available just as it is the case today for 33kV cables.
Project certification may be required, however, in this case the certification body is expected to review and accept the type test above.

Equipment optimization: We do not expect any difference here

More limited competition between available cable suppliers: It is known in the industry and substantiated via an ongoing Carbon Trust OWA project in the UK that several major well known cable manufacturers are developing 66kV cables for offshore wind application, hence there's no concerns that 66kV cables will not be available.

We know that Nexans, JDR, Prysmian and NSW are all developing 66kV cables. These are already the main players for 33kV array cables, so in that sense there is no change. With a potential market of 3.5GW it is likely that NKT, ABB and others would find it interesting to focus more on array cables, and hence the situation could actually be that competition is increased.

Re. connectors:
Pfisterer already have 66kV connectors. Eurmold are developing T-connectors, and rumours are that NKT also do.
On top of that standard cable sealing ends exist from various suppliers such as NKT. Again, a volume of potentially 3.5GW would perhaps make it interesting for others to follow, and trigger competition.

Limitations in wind turbine supply: The wind turbines that we would consider for offshore wind farms can be provided for 66kV as well. We have no concerns here.

Type and cost of installation ship required: We do not expect any difference here.

Health and safety regulations: We do not see any difference here.

We acknowledge the fact that on the longer term 66kV cables are the way forward to reduce cost. On the short term however we see that there are side effects that may cause the cost of the wind farm to increase. These potential increases may not be reflected in the maximum bidding prices set by the Government.

The document states that cables will be on the market in 2015. In our view there is still considerable uncertainty around the timely availability of 66kV cables on the market. The on-going process of testing and certification (Offshore Wind Accelerator) does not provide any guarantees that cables are coming to the market against the anticipated terms & conditions. A small number of suppliers that can manufacture the 66kV cables may limit competition and not have the cost reduction effects that are projected.

The availability of wind turbines supporting 66kV may be limited or at least uncertain on the moment of selection of a wind turbine for the purpose of creating a bid for the tender. Besides the availability the cost and contractual terms and conditions are not clear. An early switch to 66kV may limit competition and therefore have cost effects.

The high level breakdown presented in the document list a number of qualitative impacts of the items above (certification, market, financial). These may easily exceed the estimated overall LCOE savings.

Before making a final choice for 33kV or 66kV a short further investigation could be performed. Such an investigation can demonstrate the timely availability of components (cables, wind turbines) from a sufficient number of suppliers and possibly quantify the impacts mentioned in the consultation document. Given the urgency of making the choice, this investigation should start as soon as possible.

Our investigation shows that there are alternatives to a High Voltage Infield System in general.
The High Voltage System is an opportunity, which might become a requirement if the Turbine Output further increases. Important is to have enough WTG suppliers to create a competitive tender situation. Here we have doubts. It could lead to higher capex with a negative impact to the cost of the energy production.

It has been confirmed to us that the main established WTG suppliers are ready for delivering a 66kV compatible WTG. Additionally that the main cable manufacturers are ready for delivery and are already delivering certified 66kV cables.

We [OWF] will exhibit at the Hannover fair our compact 66kV switchgear especially for offshore installation (in the wind turbines). This component we enable the 66 kV connection between the OWT and the AC Platform. We currently do pilots with different WT manufactures.

7. TenneT stakeholder consultation website April

In the original paper, written by DNV GL dated March 5, 2015 (Report Nr. 113799-UKBR-R02, rev.2), the following statement was made on page 33:

"In total a CAPEX reduction of up to 15% can be achieved when using 66 kV inter-array solution compared to a 33 kV usual basic design of a 350 MW wind farm using a radial lay-out"

Is this statement still valid? And how does this 15% CAPEX reduction relate to the -1,2% LCOE reduction mentioned in the last position paper?
If the 15% cost reduction is related to the total cost of electrical infrastructure and the 1,2% to the total cost of offshore wind, this would mean that the cost of electrical infra is 8% of the total cost of an offshore windfarm. Is that correct?

Attention point for the final paper & decision: Please confirm in your final paper that the suppliers of 66 kV cables and turbines are able to submit binding bids for their equipment before the end of this year (2015).

Please find a brochure on the 8DM1 switch gear 66 kV voltage in the attachment. The switch gear has been developed specifically for offshore wind. This new product has just been launched at the Hannover Messe 2015. The 66 kV solution is available for our offshore D6 / D7 platform. Please note that no fluorinated gases are used in this switch gear.

The necessary amount of J-tube in case of 33kV will become a challenge for pull-in and cable lay operations.

8. Bi-lateral meetings

A documented process should exist to outline how this decision shall be made, including a clear timeline. This should provide clarity on how TenneT shall seek and act on industry contribution, as the choice of array voltage level as significant implications for the OWF design.

As part of the decision making process TenneT should provide a detailed paper examining the merits and risks of all considered voltage levels (e.g. 33, 66kV) from both a TSO asset and OWF asset perspective.

The TenneT paper on array cable voltage level should be informed by engagement with industry (developers, suppliers, R&D organisations). Ideally a working group involving the developer community would jointly progress this topic.

This is the most important topic. Using 66 kV makes sense. When will this decision be made? Or what are the chances for one or the other?

Manufacturers say: we will deliver if there is a request. Cable manufacturers: certification is critical (three parties working on certification). 2016 design, 2017 production, 2018 installation. Risk is on bankability, not from technical side. The certification and financiability will be taken as an uncertainty / risk premium in the BC. This is important to discuss with EZ.

It will help if developer can quantify expected level of the risk premium.

For us (OWF) it is more important to have the decision, than which type of technology it is. The technology is not critical. It is the future.

For us (OWF) management certainty with respect to grid connection is very important (ref. GE, BE). Compliments for how TenneT has organised the consultation process.

We (OWF) expected that 33 kV would be the most logical choice if it was needed to make it now. We (OWF) stated that only cowboys will be able to win the EZ tender later this year if TenneT stipulates the 66kV technology due to the additional market risks that this implies. "TenneT determines who wins the tender."

9. Other

(…)