33/66 kV Inter-array Cables for Dutch Offshore Wind Farms

A review on the TenneT cost benefit analysis and consultation process

From:	BLIX Consultancy BV
Reference:	20150615_RVO_SDB_Final_Report_33_66 kV_VF
To:	Netherlands Enterprise Agency on behalf of Ministry of Economic Affairs

Author:	Drs. Ir. Mark de la Vieter
Checked:	Ir. Albert van der Hem, Ir. Frank van Erp.
Version:	Final

Date:	15-6-2015

Executive Summary

In the summer of 2015, the Ministry of Economic Affairs (MinEZ) will determine the main technical requirements of the offshore grid in the Netherlands, in consultation with TenneT and other stakeholders, such as wind farm developers. As an input for this consultation, TenneT has started a cost benefit analysis to assess the optimal design for the offshore grid. One of the key focal points in this analysis is the input voltage of the offshore high-voltage station (OHVS) and thus the inter-array cable voltage of the offshore wind farms. The choice is between the commonly used level of 33 kilovolt (kV) or applying a higher level of 66 kV, which is generally considered a logical next step, but would be a first at this scale.

Since the choice between 33 and 66 kV is a relatively important one, MinEZ wants an independent review of the abovementioned cost benefit analysis process and a qualitative comparison of the choice for 33 or 66 kV. Via its Netherlands Enterprise Agency (RVO), MinEZ has asked BLIX Consultancy to perform this review. BLIX was supported by Energy Solutions B.V. (EnSol), a leading electrical consultant, for the technical parts of the study. MinEZ already made some basic design choices: (1) a single 700 MW OHVS to serve two sites of ca. 350 MW each, (2) a single inter-array voltage level for all five offshore wind tender rounds, for reasons of standardization and cost reduction. For the analysis performed by BLIX and EnSol, these basic design choices were fixed.

TenneT has chosen an iterative approach in providing their input to the Ministry. First, TenneT created a position paper, which they discussed with developers in expert meetings and an internet consultation. This input from the market was then included into a new revision of the position paper. BLIX and EnSol have reviewed several iterations of the TenneT position paper and, based on this input and the feedback from the expert meetings, the position paper matured. BLIX's assessment of the expert meetings on this subject is that these were properly organized and the input from the meetings was used in the discussion. BLIX also reviewed the TenneT model for the determination of the levelized cost of energy (LCOE) and found the applied assumptions and input parameters to assess the cost difference between 33 and 66 kV to be plausible.

The final iteration of the TenneT position paper shows that 66 kV is technically feasible and cost competitive. Although 66 kV inter-array cables and turbines are more expensive than their 33 kV equivalents, this effect is more than compensated by the smaller length of 66 kV cabling that is needed, due to its higher transport capacity. This could lead to a reduction of the levelized cost of energy (LCOE) of up to around 1 percent. Choosing 66 kV will enhance innovation and therefore reduce technology risk for future Wind Farm Sites. This will most likely lead to an LCOE reduction for future tenders. Technology and financing risks are not expected to be problematic either.

However, based on information of DNV-GL acquired from five major turbine manufacturers, a shift to 66 kV will limit the possibility to use smaller wind turbines (<5MW), as they will most likely not be available at 66 kV within the standard portfolio. Still, BLIX has the opinion that with five suppliers there will normally be sufficient competition with only the larger models. Moreover, there might still remain a market risk of higher priced turbines, or a higher perceived technology risks, typically associated with higher uncertainties of new innovations. Even though the chance of such a perception resulting in ineligible bids above the tender cap is small and developers do not perceive this risk to be higher than other risks, the risk of an unsuccessful tender cannot be completely excluded.

Overall, within the scope of the review (a single 700MW OHVS, one voltage for all five substations) BLIX shares the TenneT opinion that 66 kV will be the suitable inter-array voltage for the next Dutch tender rounds.

Samenvatting

In de zomer van 2015 zal het Ministerie van Economische Zaken (MinEZ) de belangrijkste technische eisen van het net op zee in Nederland bepalen. Dit gebeurt in overleg met TenneT en andere belanghebbenden, zoals ontwikkelaars van windparken. Als input hiervoor heeft TenneT een kosten-batenanalyse uitgevoerd om tot het optimaal ontwerp voor het net op zee te komen. Een van de belangrijkste aandachtspunten in deze analyse is de ingangsspanning van het offshore hoogspanningsstation (OHVS) en daarmee de inter-arraykabelspanning van de windparken zelf. De keuze is hierbij tussen het gangbare niveau van 33 kilovolt (kV) of het toepassen van een hoger niveau van 66 kV. Toepassing van 66 kV wordt gezien als een logische volgende stap, maar is tot op heden niet commercieel uitgevoerd.

Aangezien de keuze tussen 33 en 66 kV relatief belangrijk is, heeft MinEZ gezocht naar een onafhankelijke beoordeling van de bovengenoemde kosten-batenanalyse en een kwalitatieve vergelijking van de keuze voor 33 of 66 kV. Via haar uitvoeringsorganisatie Rijksdienst voor Ondernemend Nederland (RVO) heeft het ministerie aan BLIX Consultancy gevraagd om deze beoordeling uit te voeren. BLIX is hierin ondersteund door Energy Solutions B.V. (EnSol)l, een toonaangevende elektrotechnische consultant, voor de technische onderdelen van de studie. MinEZ heeft al de volgende basale ontwerpkeuzes gemaakt: (1) een OHVS van 700 MW die twee kavels van elk ca. 350 MW bedient, (2) een gelijke inter-arraykabelspanning voor alle vijf offshore wind tenderrondes, ter standaardisatie en kostenreductie. Voor de analyse van BLIX en EnSol waren bovenstaande basale ontwerpkeuzes gefixeerd.

Bij het leveren van hun inbreng aan het ministerie heeft TenneT voor een iteratieve aanpak gekozen. Als eerste creëerde TenneT een position paper; deze werd vervolgens in expertmeetings en via een consultatieronde via internet met ontwikkelaars besproken. BLIX en EnSol hebben verschillende iteraties van de TenneT position paper en gereviewd. Op basis van deze input en de feedback tijdens de expertmeetings is de position paper vervolgens aangepast. BLIX is aanwezig geweest bij de expertmeetings en is van mening dat deze goed waren georganiseerd en dat de input van de vergaderingen gebruikt is in de discussie. BLIX heeft ook het door TenneT gebruikte kostenmodel gereviewd, waaruit bleek dat de in het model gebruikte aannames en invoerparameters terug te voeren zijn tot de in de position paper gepresenteerde data.

De laatste iteratie van de TenneT position paper laat zien dat 66 kV technisch haalbaar en kosteneffectief is. Hoewel 66 kV inter-arraykabels en turbines duurder zijn dan hun 33 kV-equivalent, wordt dit effect meer dan gecompenseerd door de kleinere benodigde lengte van 66 kV kabels, aangezien deze een hogere transportcapaciteit hebben. Uiteindelijk kan de keuze voor 66 kV op deze manier leiden tot een vermindering van de LCOE met maximaal 1 procent. Daarnaast zal een keuze voor 66 kV innovatie te stimuleren en daarmee technologierisico's voor toekomstige windlocaties verminderen. Dit zal waarschijnlijk leiden tot een lagere LCOE voor toekomstige tenderrondes. Technologie en financieringsrisico’s zijn bovendien naar verwachting niet problematisch.

Uit een analyse van DNV-GL op basis van informatie van vijf grote turbinefabrikanten blijkt echter wel dat een verschuiving naar 66 kV de mogelijkheid om kleinere windturbines (<5 MW) te gebruiken, zal beperken. Dergelijke kleine molens zullen waarschijnlijk niet binnen de standaard portfolio op 66 kV beschikbaar zijn. Toch is BLIX van mening dat er met vijf leveranciers normaal gesproken voldoende concurrentie is op basis van alleen de grotere modellen. Daarnaast blijft er een gering marktrisico bestaan van duurdere turbines of door ontwikkelaars hogere gepercipieerde technologierisico's, welke doorgaans geassocieerd worden met nieuwe innovaties. Hoewel de kans dat dit zal leiden tot inschrijvingen boven de tender cap klein is en ontwikkelaars dit risico niet groter achten dan andere risico’s, kan het risico van een onsuccesvolle tender niet volledig worden uitgesloten.

Binnen de scope van dit onderzoek (één 700MW OHVS, één spanningsniveau voor alle vijf tenderrondes), deelt BLIX de mening van TenneT dat 66 kV het meest geschikte inter-array spanningsniveau is voor de komende Nederlandse tenderrondes.

Contents

1 Introduction

1.1 The choice for 33 or 66 kV

As part of the Dutch Energy Agreement for Sustainable Growth, the Dutch roll-out strategy for ca. 3500 MW offshore wind has changed to a system in which the government tenders offshore wind sites ('kavels' in Dutch) to the market. The winner of a site will receive the necessary permits and an exploitation subsidy. The Dutch government has appointed Dutch TSO TenneT to become the offshore grid operator, responsible for the connection to the mainland electricity grid. In this situation, the tender winner will connect its wind farm to a TenneT offshore high voltage substation ('OHVS') (see Figure 1) and TenneT will provide the connection to the mainland.

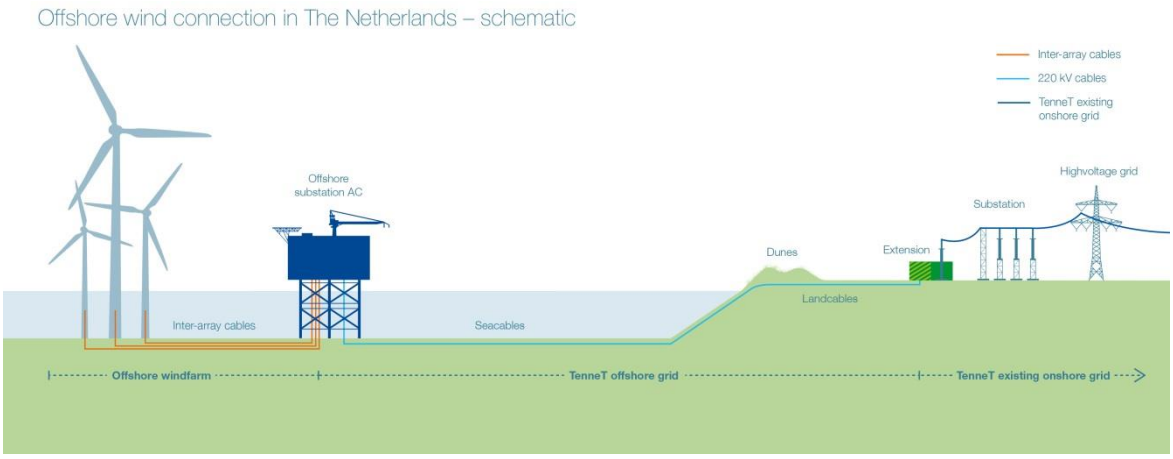


Figure 1: Schematic depiction of the future Dutch offshore wind connections in the Netherlands (source: TenneT)

In the summer of 2015, the Ministry of Economic Affairs will determine the main characteristics of the offshore grid in consultation with TenneT and other stakeholders. As an input for this consultation, TenneT has started a cost benefit analysis to assess the optimal design for the offshore grid. One of the key focal points in this analysis is the input voltage of the OHVS and thus the inter-array cable voltage of the offshore wind farms. The choice is between the commonly used level of 33 kilovolt (kV) or applying a higher level of 66 kV, which is generally considered a logical next step, but would be a first at this scale. A choice for 33 kV is a choice for proven technology with a solid track record and comparatively low risks. A choice for 66 kV is a choice for a new development with potential cost savings, but the technology has not been applied at a commercial scale, which might result in additional risks. In the light of standardization, TenneT has a preference to choose a single voltage for all five OHVS that are planned until 2023.

1.2 The TenneT Process

TenneT has the following approach in their cost benefit analysis for inter-array voltage:

1. TenneT has commissioned DNV-GL to create a whitepaper with a technical analysis of the differences between 33 and 66 kV and their cost implications (technology associated costs).
2. TenneT (supported by Ecofys) uses the analysis in the whitepaper as input for an LCOE calculation in which a back- to-back comparison between 33 and 66 kV is performed.
3. Based on the whitepaper and LCOE calculation, TenneT (supported by Ecofys) creates a position paper in which they present a motivated preference for either 33, or 66 kV.
4. This position paper is discussed during the expert meetings, during which developers can comment on the position paper and propose additional input.
5. TenneT has commissioned DNV-GL to perform an additional supplier consultation, and based on this the position paper is adjusted and finalized.

1.3 The role of the Ministry of Economic Affairs

As part of the main technical requirements, the Ministry of Economic Affairs (MinEZ) will set the standard for the voltage level of the inter-array cables, in consultation with TenneT and other stakeholders. In their decision process, MinEZ considers the solution that leads to:

- The lowest Levelized Cost of Energy (LCOE), in the light of an overall cost reduction of 40% for offshore wind, as agreed in the Energy Agreement;
- Reduction of the following risks:
    - unsuccessful tender due to high perceived risks and costs by developers;
    - delays during construction due to unforeseen technical difficulties.

To facilitate this choice, MinEZ wants an independent review of the TenneT process and calculations and a qualitative comparison of the choice for 33 or 66 kV. Via its Netherlands Enterprise Agency RVO, MinEZ has asked BLIX Consultancy to perform this review.

1.4 The BLIX assignment

On behalf of the Ministry, BLIX has assessed the process and the results of the TenneT cost benefit analysis. The assessment consists of the following parts:

- A review of the TenneT process towards the cost benefit analysis (e.g. expert meetings) – see chapter 2.
- A review of the correctness and the completeness of the different iterations of the TenneT position paper and underlying costing document. This includes the assessment of the costing model that TenneT uses to assess the LCOE impact of the choice for either 33 or 66 kV – see chapter 3.
- Independent market insight on the basis of interviews with suppliers and developers – see chapter 4.
- A discussion of the pros and cons of both voltage levels, based on the position paper and the previous chapters – see chapter 5.

Part of the analysis was performed by Energy Solutions B.V. (EnSol), a leading offshore electrical consultant, as a subcontractor of BLIX.

1.5 Assumptions and limitations

Some basic design choices for the offshore high voltage stations (OHVS) were already made by MinEZ and TenneT:

1. The Roadmap for 3500 MW offshore envisions five tender rounds of around 700MW, in mind, in which a single 700MW OHVS will be placed to serve two sites of ca. 350 MW each.
2. For reasons of standardization and cost reduction a single design for OHVS and inter-array voltage level will be chosen for all five offshore wind tender rounds. Therefore, a choice for an inter-array voltage during the first tender will be a choice for all following tenders as well.

For the analysis performed by BLIX and EnSol, the above basic design choices were fixed. Especially the choice for an OHVS capacity of 700 MW influences the choice between 33 kV and 66 kV for the inter-array cabling, as a 33 kV system might have significantly benefitted from using two smaller OHVS.

2 Review TenneT consultation process

2.1 The final position paper includes all relevant remarks

The process towards the final TenneT position paper (date 23-4-2015) has included several iterations of the position paper and two expert meetings with developers. Based on the input during the first expert meeting and based on the review by BLIX and EnSol, additional work was carried out by TenneT. The following table provides an indicative timeline of the process towards the final position paper.

Date	Activity	Remark
3-3-2015	DNV-GL whitepaper and TenneT position paper (V1) issued	
18-3-2015	Expert meeting (developers)	Several additional questions were raised, to be answered in next version of position paper
23-3-2015	New version (V2) of position paper issued	Issues mentioned during expert meeting were included
24-3-2015	Steering Committee (TenneT, Ecofys and MinEZ)	Preliminary findings of BLIX were presented and used as input for TenneT
14-4-2015	New version of position paper (V3) and a document with answers to additional questions (DNV-GL) issued	New version includes answers to questions raised during expert meeting and steering committee. These answers were prepared by DNV-GL in a separate document.
18-4-2015	Expert meeting (developers)	Issues on availability of smaller turbines at 66 kV raised
23-4-2015	Final version position paper (V4) issued	Version includes additional information on turbine supply
25-4-2015	Steering Committee	Approved position paper

Overall, BLIX has the opinion that all relevant input has been included into the final iteration of the position paper.

2.2 Expert Meetings

BLIX and RVO have attended two Market Consultation sessions that dealt with the subject “33/66 kV”.

- The first Market Consultation was an open discussion in which 4-5 issues were raised. These issues were addressed in the next version of the position paper.
- The second Market Consultation was a more informative session, during which no new issues were raised.

The consensus of the market after both sessions was that 66 kV is feasible, although a minority of developers favors 33 kV due to internal standardization in their project management and supply chain. Moreover, several developers mentioned the positive effect in terms of accelerating the development of 66 kV equipment when the Dutch government announces 66 kV to become the inter-array cable voltage standard. Finally, several developers have indicated that they perceived the TenneT/Ecofys Market Consultation to be a positive and constructive process. Concluding, the market currently has enough confidence in 66 kV and welcomes an early decision from the Minister.

3 Review TenneT position paper

3.1 Review first version of position paper and underlying whitepaper

BLIX has performed a review of the first major revision of the TenneT position paper and the underlying whitepaper. EnSol has been contracted to perform (part of) the technical review. The results of the BLIX/EnSol analysis have been discussed with TenneT and have generally been included in the next revisions. The following table shows an overview of the major issues found by BLIX/EnSol, and how they have been resolved in following versions.

Issue in March version of position paper	Status in final version of position paper
The position paper appeared to have a stringent view on standardization with a fixed design for all five platforms	The current position paper leaves room for incremental innovation in the design, based on lessons learned during the construction of previous platforms
The position paper seemed biased towards 66 kV	More neutral formulation
The conceptual designs for 33 and 66 kV were not optimized, biased towards 66 kV and maybe not appropriate for “Hollandse Kust” tender rounds	Strong analysis in the position paper was added, which assesses the cable impacts for both 33 and 66 kV for all five tender rounds. While still not optimized, BLIX and EnSol agree that the design is not biased towards either voltage level
Cable costing confusing and sometimes contradicting	Clarified in new version of position paper
Often the best case costing data were used in the LCOE analysis	The position paper now uses a range.
The availability of cost effective 66 kV cables was not sufficiently researched	The position paper now includes an analysis
The availability of cost effective 66 kV turbines was not sufficiently researched	The position paper now includes an analysis, which shows that all major turbine manufacturers are able to provide a 66 kV solution. However, only the larger (>=5MW) turbines in the portfolio will most likely be adapted to 66 kV

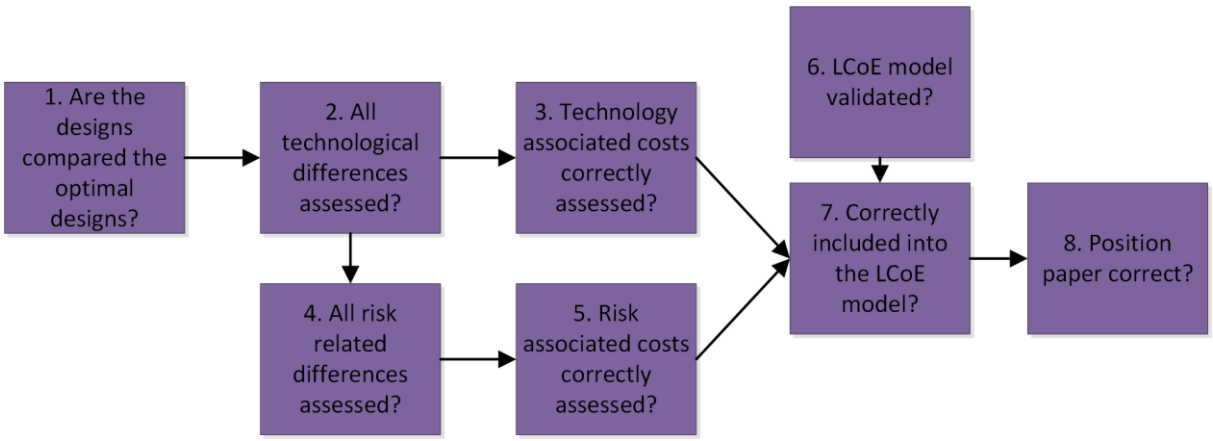
3.2 Review of the TenneT costing model

BLIX has reviewed the assumptions of the TenneT costing model (prepared by Ecofys) that was used to calculate the LCOE impact of the 33/66 kV design choices. The relevant assumptions, input parameters and parts of the model that differ between 33 and 66 kV have been heavily scrutinized, the rest of the model only globally. The model appeared complete and correct and all relevant assumptions could be traced back to the TenneT position paper, or the DNV-GL whitepaper.

Since BLIX did not validate the model itself, the completeness and correctness of the model have not been assessed. However, the TenneT model is directly derived from the model that has been prepared for the TKI Offshore wind, which has been independently validated by a third party.

3.3 Review of the final version of the position paper

As mentioned in the previous paragraph, most of the remarks and questions made by BLIX/EnSol have been followed up in the final revision of the position paper. BLIX has used the following model with 8 research questions to assess the completeness and correctness of the position paper.



The answers to the 8 research questions can be found below:

1. The conceptual designs used for both the 33 kV and 66 kV scenario have been assessed by BLIX and EnSol. While the cable layouts were still not optimized, BLIX and EnSol agree that the designs were not biased towards either voltage level. Moreover, five layouts have been created for the five tender rounds, and the cost impact of the 33/66 kV choice has been calculated for all five layouts.
2. All relevant technological differences have been assessed (most notably: cables, WTG, cable length).
3. The position paper assesses the costs of the technological differences correctly. However, the cost impact of the likelihood that a shift to 66 kV does in fact eliminate the possibility to use smaller turbines has not been assessed. More information on this topic can be found in chapter 5 “Discussion”.
4. Since application of an inter-array voltage level of 66 kV at a commercial scale is new, additional risks might occur, such as technology risk (since the technology has not been applied commercially), procurement risk (higher prices due to scarcity) or financing risk (higher as a result of the perceived risks by insurers and banks). These risks have all been taken into account in the position paper.
5. TenneT has found that cable and wind turbine manufacturers provide identical warranties for 33 and 66 kV solutions. This, combined with the assumption that insurers and banks will not charge a risk premium when warranties are identical, leads to the conclusion that TenneT does not expect risk associated costs. However, since 66 kV is a new technology, additional risks might still occur. More information on this topic can be found in chapter 5 “Discussion”.
6. BLIX has assessed the assumptions and results of the LCOE model and found no irregularities. Moreover, a previous iteration of the model has been validated before by a third party.
7. BLIX has assessed the assumptions of the LCOE model and all inputs in the model could be traced back to the whitepaper or position paper.
8. Overall, the position paper contains a solid analysis, based on a DNV whitepaper and market analysis, which concludes that 66 kV is technically feasible and cost competitive. Choosing 66 kV will increase innovation and therefore reduce technology risk for future Wind Farm Sites. BLIX will discuss the most relevant aspects of the 33/66 kV choice in chapter 5 “Discussion”.

4 Own research

BLIX has, independently from TenneT, contacted several cable and turbine suppliers to provide input on costing differences between 33 and 66 kV equipment. Moreover, several developers were interviewed briefly in order to get a broad overview of the market and validate the outcome of the TenneT market consultation. Because the information from developers and suppliers has been acquired using short and confidential interviews based upon sensitive market information, the results have been anonymized.

4.1 Cable and Turbine Suppliers

Both 66 kV cables and turbines will be more expensive than their 33 kV equivalents. This effect, which is also incorporated into the TenneT position paper, is offset by the fact that less 66 kV cabling is needed due to the higher transport capacity. The following table provides availability and pricing info, provided by leading cable and WTG manufacturers.

Supplier	Availability	Pricing
Cable Supplier 1	Available for offerings in 2015 if a developer has a real project	Higher, but no commercial mark-up
Cable Supplier 2	Available for offerings in 2015 if a developer has a real project	Higher, but no commercial mark-up
WTG Supplier 1	Ready to offer their largest WTG at 66 kV	No commercial mark-up
WTG Supplier 2	Ready to offer their largest WTG at 66 kV	No commercial mark-up
WTG Supplier 3	Ready to offer larger WTGs at 66 kV, smaller ones are not on offer anymore	No commercial mark-up
WTG Supplier 4	Ready to offer larger WTGs at 66 kV	No commercial mark-up
WTG Supplier 5	Ready to offer their largest WTG at 66 kV	No information

The overall picture supports the conclusion of the TenneT position paper that the consensus among turbine suppliers is that for 66 kV cables and 66 kV adapted turbines, binding offers can be supplied at competitive pricing in 2015. However, only the larger turbines can be acquired at 66 kV.

4.2 Contractors/developers

The following table provides an indication of the sentiment amongst international contractors and developers.

Developer/ Contractor	General/Technology	Pricing
Developer 1	No technical bottlenecks	No information
Developer 2	Already considers 66 kV for current projects, but timing /risk certification has to date been an issue.	No commercial mark-up foreseen
Developer 3	Already considers 66 kV for current projects, but timing /risk certification has to date been an issue.	No commercial mark-up foreseen
Developer 4	Already considers 66 kV for current projects, but timing /risk certification has to date been an issue. WTG procurement not an issue, logistic advantages.	No commercial mark-up foreseen
Developer 5	No technical bottlenecks	No commercial mark-up foreseen
Developer 6	No technical bottlenecks, prefers 33 kV	No information
Developer 7	No technical bottlenecks, certification an issue	Risk Associated Costs will increase price

Concluding, developers seem to be generally confident that they can prepare a competitive bid when the voltage level will be set to 66 kV. Most important at this stage is that a decision for a voltage level is made urgently. This is in line with the outcome of the expert meetings, organized by TenneT.

5 Discussion

As mentioned in the introduction, the Ministry strives for the lowest LCOE and a reduction of the risk of an unsuccessful tender and delays. Based on the TenneT studies, the BLIX review and interviews with experts, it appears that it is most probable that - compared to 33 kV - the LCOE of 66 kV will be comparable, or even slightly lower (possibly 1%) for the first tender, with an increasing advantage (up to a few percent LCOE reduction) in the next tenders, as technology matures. Cost effective procurement of wind turbines and cables should not be problematic. Even when excluding smaller turbines when choosing 66 kV, BLIX has the opinion that with five suppliers there will be sufficient competition with only the larger models. However, there are some aspects to the discussion that still remain and which are of interest to MinEZ.

5.1 66 kV and innovation

66 kV is a new technology which will most likely be the standard in the near future. Choosing 66 kV right now will create a stable market demand, increase innovation and therefore reduce technology risk for future wind farm sites. Moreover, it is possible that suppliers will strive to be the first to demonstrate their 66 kV products in this new market, leading to lower costs.

5.2 66 kV and the risk of an unsuccessful tender

Risk is defined as the chance of an incident, multiplied by the effect of the incident. The position paper states that the chance that additional risks occur for 66 kV, will be (close to) zero because of several reasons:

1. Low Technology Risk: suppliers have indicated that they will be able to provide turbines and cables with identical warranties.
2. Low Procurement Risk: there will be enough suppliers to prevent a mark-up.
3. Low Financing Risk: No risk premium will be charged if warranties are similar.

However, the paper does not elaborate on the effects of the risks materializing. BLIX has the opinion that, even though these risks are low, they cannot be completely excluded. Since 66 kV is a new technology, there might still remain a (perceived) market risk of higher priced turbines, unforeseen circumstances and limited availability of reference price information. In the proposed tender system, with a maximum tender cap (above which bids are ineligible) the way these risks are perceived could result in ineligible bids above the tender cap.

This is shown simplified and schematically in the next figure (without realistic numbers). Even though the expected price for 66 kV is lower, the bandwidth for the (perception of the) bid price is higher due to higher uncertainties. In some cases, this could lead to reaching the tender cap, resulting in an unsuccessful tender.

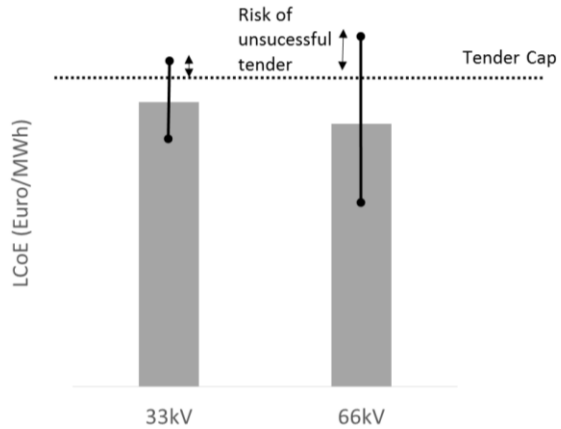


Figure 2: A schematic depiction of the risk of an unsuccessful tender for a situation with a lower expected value but a higher standard deviation

The chance of an unsuccessful tender will be the largest during the first tender round when 66 kV is still relatively new and decreases during later rounds as 66 kV is applied more often. However, during TenneT's consultation process and expert meeting none of the wind farm developers has indicated that a choice for 66 kV would increase their risk, leading to ineligible bids above the tender cap. The developers just requested for an early decision on the voltage level in order to timely prepare and focus their bids.

5.3 A choice for 66 kV limits the possibility to use smaller turbines

As mentioned before, a shift to 66 kV limits the possibility to use smaller turbines. Based on information acquired from several projects in which BLIX is involved, BLIX has the opinion that turbines of around 4MW could still be cost competitive in specific cases. However, since all five large WTG suppliers are willing to provide turbines at 66 kV there will normally be sufficient competition with only the larger models. From a technology perspective, a choice for a larger turbine is a choice for a newer, commercially less proven technology. However, most developers stated during the expert meeting that they were planning to use larger turbines for the Borssele site already.

6 Conclusion

BLIX and EnSol have reviewed several iterations of the TenneT position paper and underlying documents. Based on this input and the input from the expert meetings, the position paper has matured and improved in correctness and completeness. The expert meetings with developers were properly organized and the input from the meetings has been used in the position paper. BLIX has reviewed the TenneT LCOE model assumptions and did not find any irregularities.

The position paper shows that 66 kV is technically feasible and cost competitive. Choosing 66 kV will enhance innovation and therefore reduce technology risk for future Wind Farm Sites. This will most likely lead to an LCOE reduction for future tenders and possibly already in the first year. Technology and financing risks are not expected to be problematic either.

However, based on information of DNV-GL acquired from five major turbine manufacturers, a shift to 66 kV will limit the possibility to use smaller wind turbines (<5MW), as they will most likely not be available at 66 kV within the standard portfolio. Still, BLIX has the opinion that with five suppliers there will normally be sufficient competition with only the larger models. Moreover, there might still remain a market risk of higher priced turbines, or higher perceived technology risks, typically associated with higher uncertainties of new innovations. Even though the chance of such a perception resulting in ineligible bids above the tender cap is small and developers do not perceive this risk to be higher than other risks, the risk of an unsuccessful tender cannot be completely excluded.

Overall, within the scope of the review (a single 700MW OHVS, one voltage for all five substations) BLIX shares the TenneT opinion that 66 kV will be the suitable inter-array voltage for the next Dutch tender rounds.