FEEDBACK REPORT

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1. Expert Meeting 27.11.2014

TenneT presented the current activities within the EU which should result into a new network code: "Requirements for Generators". This code includes requirements for Power Park Modules and will become mandatory for OWF. From the topics mentioned the compensation requirements were challenged and discussed in length. TenneT recognized the fact that the OWF would have less options to mitigate reactive power without the offshore infrastructure. OWF recognized the fact that what can be delivered by the turbines should be part of this requirements to realize the most economical solution. Parties emphasized the approach to use standard type of turbines and not require modified (and therefore expensive) models. TenneT recognized this concern, but will be bound by the new RfG and can only use discrete infrastructural equipment in an economical way. Parties proposed to have TenneT study a "typical" wind park with sensitivity analysis for the design of the concept and the requirements for the OWF regarding the compensation requirements. With respect of each other's responsibilities and flexibility TenneT accepted to further investigate how this item could be addressed in a proper way.

2. Expert Meeting 29.01.2015

N.A.

3. Expert Meeting 18.03.2015

N.A.

4. TenneT stakeholder consultation website April

General RfG

We agree with the comments stated in the Feedback report section 5.

From our quick review of the RfG draft that has been circulated (email 12/12/2014) we have some concerns about TenneT taking the maximum of the ENTSO-E Network Code RfG envelopes eg. for FRT and reactive capability. Our concern is that such requirements applied to an offshore MV connection point (basically applicable at the end of the string) will be much more challenging to the PPM than if applied to the onshore PCC at HV. Since PPM has no possibility of installing additional equipment (eg additional reactive compensation) in order comply with the RfG requirements issues may be insolvable or in best case very costly.

We do urge TenneT to consider the need for these requirements and assess the feasibility of PPM to provide the various services from a global perspective.

Power quality
The Network Code does not cover power quality such as harmonic distortion. Could TenneT please elaborate on these requirements.

In relation to power quality, we would not recommend that different PPMs are connected to the same transformer. The power quality issues will become very complex and potential converter interactions may jeopardize the stability of the WTGs.

Here it should also be considered that resonances in export system and any neighboring PPM may influence the harmonic distortion beyond the control of the affected PPM.

Measurements in interface point
As mentioned under SCADA we would also ask to have transient and power quality recorders for on-line measurement of the wind farm performance in the reference point in order to be able evaluate the compliance with codes. Generator will need to access to these fault recorders / power quality measurement in the PCCs.

For the stability of the system the reactive power range provided by the OWP and the grid connection system (220 kV-cable) at the onshore grid connection point is relevant. So the reactive power (capacitive) of the 220-kV-cable has to be taken into account when determining the reactive power range of the OWP. This leads to a reactive power range shift of the OWP towards the underexcited region. So unnecessary high demand regarding overexcited reactive power behavior of the OWP should be avoided in order to avoid stranded investments.

The ACM is expected to approve the offshore grid code in September after which it will become legally binding. There seems to be a formal issue that, at the moment, the Electricity Act has no basis for an ACM decision on this code but the ACM is apparently willing to take the decision anyhow but it will only become legally binding at the moment the new Electricity Act is implemented.

5. TenneT stakeholder consultation website May

Harmonics and transients
The Network Code does not cover power quality and transients.

TenneT has informed us that the specification of harmonic and transients will not be ready before end of 2015. This is late and problematic with regards to our assessment of the power quality requirements and risks in connection with the bid. Limits need to be specified in the tender documents.

Another important issue is the back-ground harmonics. We understand that TenneT haven't planned any filter in the onshore substation. Experience from both UK and Danish projects is that large cable systems

create harmonic resonances that will amplify background harmonics in transmission interface point. The experience from UK is that basically all projects have harmonic filters in the onshore substation in order to mitigate this. There is also a risk that these amplified background harmonics may be seen in offshore interface point between TenneT and OWF and have significant impact on compliance.

In any case background harmonics should be clearly specified together with the (incremental) limits applicable to the wind farms. Here neighboring wind farm emission should be included as well.

6. TenneT stakeholder consultation website June

Fulfilling the grid code is a combined responsibility of the wind farm owner combined with the substation owner.

It is important that TenneT shows that with the substation delivered is possible to fulfil the grid code in cost efficient way.

Experience shows that wind turbine manufacturers do not take responsibility for fulfilling the grid code. Which makes the possibilities limited for the wind farm owner to handle issues when not owning the OSS. General rule of thumb is that issues are less expensive to solve on the substation. Moreover, it might be the only place where these can be solved.

Reactive power compensation: We advise TenneT to do a full market study on reactive power compensation capabilities of the turbines (with and without the optional statcom) and perform a simulation including a worst case array cable. In this way TenneT can show whether the grid code can be fulfilled.

It should be assessed whether installing reactive power compensation on the OSS is more cost efficient than installing statcoms on all turbines.

Harmonics: Because harmonics problems often can only be solved on the OSS TenneT should show that the designed OSS should be able to comply with allowed harmonics levels. Depending on grid code(and headroom available) it might be necessary to have an harmonic filter on the OSS. If there is the chance that harmonics need to be compensated, for any particular turbine there should be room for it on the OSS in the onshore substation.

Other requirements RfG/grid code: To give clarity on the requirements for the wind farm owner and comfort that these can be met, a check on the grid code/future RfG, etc. on whether (fail to ride through etc.) to show that fulfilling the grid code can be done with the current substation design. This would include an insight in the content in the (future) offshore grid code for the wind farm owner in the Netherlands. E.g. fault ride trough is managed by TenneT in the substation, but is included in the offshore RfG. At the moment it is not clear how the grid code is this translated into a proper grid code suitable for this situation?

7. Bi-lateral meetings

Following the TenneT meeting of 27th Nov 2014 it is understood that TenneT will provide a paper in relation to the Grid Code / RfG compliance requirements which take notice of the fact that (i) the OWF will have no space at OSP to accommodate centralised solutions and (ii) the intent of the OWF developers, to minimise risk, is to employ standard WTGs rather than 'specials' – for example that may not be certified/certifiable.

We (OWF) would request that TenneT give consideration to transmission based solutions where this presents the most economical solution or the most sensible solution from a risk perspective. For example, in the UK the offshore transmission provider is responsible for provision of reactive range, voltage control and power quality measures at the onshore interface point rather than at the offshore grid entry point – but options still exist in the UK to provide part capability in these areas from the OWF where this presents a more economical solution.

When will TenneT new offshore code (RfG compliant) be available?

We (OWF) have not attempted to provide commentary on the potential implications of different aspects of the RfG / TenneT Grid Code as this stage, this will be done following receipt of the paper referred to in the first bullet. When determining the rating of OSP switchgear on the LV side of the OSP then design interaction is required between TenneT and the OWFs – (i) obviously to understand the WTG fault contribution (ii) but also to ensure switchgear rating available/offered by WTG suppliers are adequate to accommodate design fault levels – for example, choice of TenneT OSP transformer impedance could have a material impact on WTG switchgear rating/cost/availability. We (OWF) seek close liaison with TenneT on such design issues.

Please note that we (OWF) need more information. Priority closely following 66 kV decision.

8. Other

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