

Overview of harmonic compliance studies of large windfarms in The Netherlands

C4 PS1 Q1

On the subject of management of PQ in evolving power systems,
what are the difficulties/drawbacks with the existing approaches?

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Overview of harmonic compliance studies of large (type D) windfarms in The Netherlands

In support of various wind farm (WF) developers, Energy Solutions performed as well as reviewed many pre-connection harmonic compliance studies of type D WF in the past years.

Main characteristics of the studies:

- WF power level between 80 MW and 400 MW, 15 – 90 Wind Turbine Generators
- Connection point voltage level: 50 kV – 150 kV
- Connected directly to TSO, directly to DSO or to TSO via privately owned distribution system
- Scope:
 - Wind Turbine Generators (WTG) + array cables (offshore only)
 - WTG + array cabling + step up transformer
 - WTG + array cabling + step up transformer + export cable (up to 55 km)

Assessment method characteristics and trends

- Assessment methodology:
 - TSO /DSO provides impedance envelopes for each (group of) harmonic order(and limits for each harmonic order
 - WF to determine maximum voltage distortion U_{hi} (%) per harmonic order over complete impedance envelope at PCC taking all possible operational states of WTGs and WF passive components into account
- Trends
 - Some low order harmonic orders usually exceed limits (in range of $h = 2 - 15$)
 - Compliance still can be achieved by:
 - TSO/DSO checking exceedance plot on actual loci
 - Emission U_{hi} reduced by phase angle randomization for even harmonics
 - Drawback: only limited converter/WTG OEM provide supporting measurements

Examples

- <<I will add some examples of exceedance plots and how compliance was achieved. I also will try to add some additional assessment such as impact of length of export cable on exceedance. Sometimes the export cable is actually beneficial to the emission level of certain harmonic order.
- If this contribution is accepted, I can finalise the presentation on 12-8 or 15-8 latest as I'm currently on holiday and have no access to the actual study reports.
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