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LOW-HarM

Large Offshore Wind Harmonics Mitigation

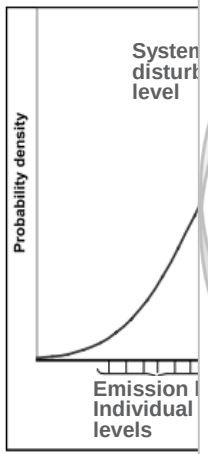
Peter Eecen

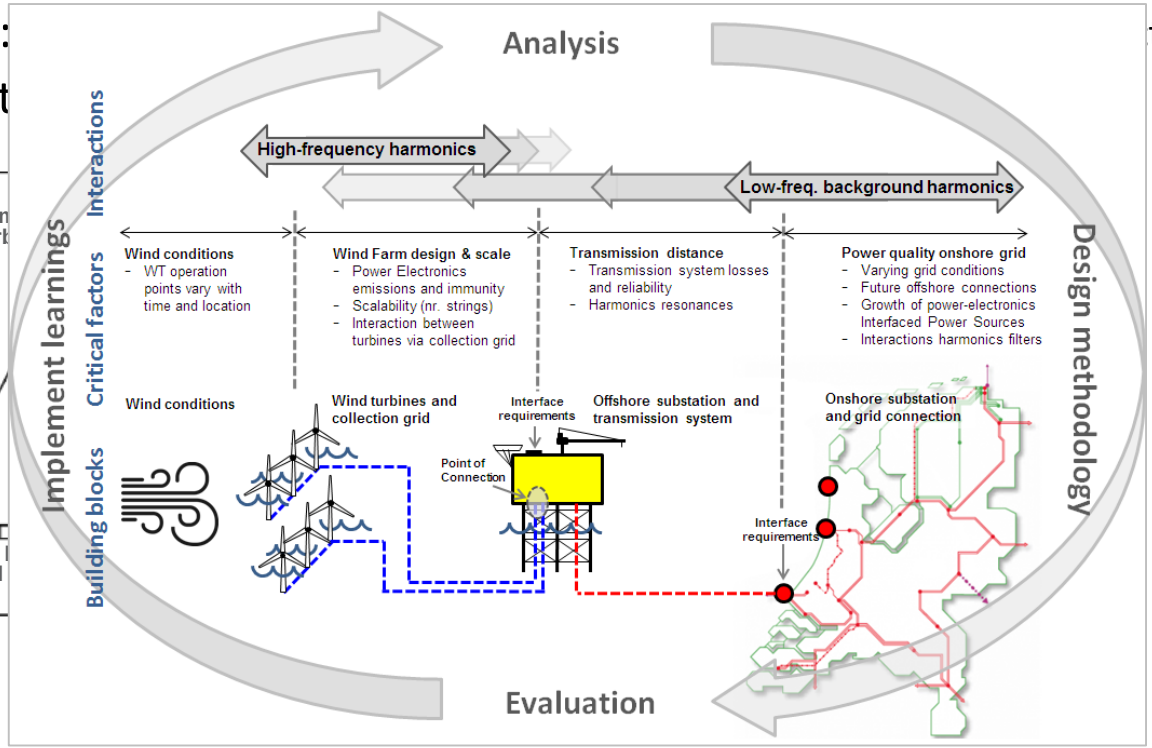
TKI matchmaking day, February 14, 2017

www.ecn.nl

Project description

- Goal: Methodology to design lean measures to mitigate adverse effects of harmonics in OWFs
- How: Analyze, design, validate and implement improved design methodology
- Result:
- Impact





Project team

Partner	Role in project	Description
ECN	Coordinator Leading WP1 “Exploration” and WP3 “Modelling, simulations, case studies”	
TenneT	Project management Keep focus on requirements, solutions and recommendations: focused on real-world problems and needs.	Transmission system operator in NL & Germany. Active in standards and grid code development. Responsible party for offshore grid development
CG-Power Systems (Belgium)	Input experience and component data Contribute to case definition and simulation and implementation	Supplier of high-voltage equipment and turn-key systems, e.g. for all TenneT offshore substations
Energy Solutions	Share experience and provide models. Contribute to case definition and simulation.	Internationally leading system designer of electrical systems for offshore wind farms.
TU/e	Analysis, modelling, simulation transmission system. Input to standardization working groups	Internationally leading university; key expertise on power quality.
TU-Delft	Analysis, modelling and simulation wind farm.	Internationally leading university; key expertise on electrical power conversion and DC systems.

Project WP structure

July 2017

Feb 2018 →

Sept 2019

WP 1	**Exploration** *WP leader - ECN*		
	1.1 Common practice & Experience *TenneT, Ensol, CG-Power* - Simulation programs - Design methods & application limits - Design limits of components - Operational experience	**1.2 Literature** *TU/e, TU-Delft, ECN* - OWF and technology trends - Literature - Current standards	**1.3 Scenarios and Trends** *TenneT* - OWF and technology trends - Responsibilities
WP2	**2 Development of design methodology** *WP leader - TenneT*		
	2.1 Harmonics fundamentals *TU/e, TU-Delft* - Description of the fundamental phenomena and their effects (sources, frequencies, damping, penetration depth)		**2.2 Design methodology** *ECN, EnSol, TenneT, CG-Power* Under condition of: - scalable - expandable - manageable
WP3	**Modeling, Simulation & Quantification of case studies** *WP leader - ECN*		
	3.1 Case definition & design *EnSol, CG-Power, ECN* - Case A: Existing wind farm - Case B: Large offshore wind farm AC - Case C: Large offshore wind farm DC	**3.2 Simulation** *EnSol, CG-Power, TU/e, TU-Delft* - based on existing software	**3.3 Results & evaluation** *all partners* - Verification simulation Case A & available measurements - Recommendations & findings for Case B/C
WP4	**Requirements for measurement campaign** *WP leader - TenneT*		
WP5	**5 Generalization and best practices** *WP leader - TenneT*		
	5.1 Best practices *all partners* - design guidelines	**5.2 Interface requirements** *all partners* *- roles and responsibilities of stakeholders* *- review sessions*	**5.3 Input for standardization** *all partners* - Input for standardization working groups (white paper)

Thanks…
Questions?

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