New Validation Method for Models for Grid Studies

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Motivation for this publication

Our goal: create awareness and broaden acceptance in the industry for the approach of validating grid models of wind turbines with reference models
New Validation Method for Grid Models

- Validated grid models – how to get there
- Comparison between different validation methods
- Experiences with the new approach and outlook
## Validated Grid Model of Wind Turbines and Wind Farm Components FAQ

### Who asks for validated models?
- Transmission System Operators (TSO)
- Clients of turbine manufacturers
- Certifiers
- Public authorities

### When are validated models needed?
- through all phases of turbine life-cycle

### What are validated models used for?
- to gain approval of grid access
- to verify turbine and windfarm properties in interaction with the grid
- to dimension windfarm components

### What validation guidelines do exist?
- National, e.g. FGW TR4, TR8
- International, e.g. IEC 61400-27
- Project specific
Customer Models for Grid Studies

- Grid operators require **RMS** (root mean square) models of WTGs for grid studies
- Alternatively generic models can be used in some markets (WECC, IEC)
- For instantaneous value analyses **EMT** (electromagnetic transient) models are required

Common Simulation Platforms:

<table>
<thead>
<tr>
<th>RMS</th>
<th>Generic</th>
<th>EMT</th>
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![Simulation Platforms](image)
Grid models describe grid relevant parts of windfarm components like turbines.

Performing Model Validation

1. Active power positive sequence TR4
Validated grid models – how to get there

Comparison between different validation methods

Experiences with the new approach and outlook
Fault Ride-Through (FRT) measurement with dedicated testing device (container)

### Advantages of measurements
- Close to the truth
- Accepted proof of wind turbine generator (WTG) properties

### Disadvantages of measurements
- Huge effort in equipment and adaption of WTG
- Requires significant manpower
- Point of Common Coupling (PCC) needs to have specific properties
- Non-deterministic environment
- Only some relevant tests can artificially be excited: FRT, power quality, P-steps
- Not possible: grid frequency changes
■ Subsystems represent most detailed modelled components, including original control algorithm
■ Calculation of instantaneous values
### Advantages
- Highly detailed
- Deterministic results
- Easy adjustments of operation conditions
- More analyzed operating points in less time
- Easy exchange of components to support variants
- Debugging in the office
- Fosters model-based design

### Disadvantages
- Large computational effort, resulting in long simulation times (comparable to EMT-models)
- High modelling expertise required (model architecture, numerics, co-simulation, variants, tools for automated operation)
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Experiences and Outlook

So far the approach was used for a major offshore project, where late requirements changes to the turbine made changes to the model necessary. Another major project is currently in progress.

Outlook
- Continuous validation of the reference model with measurement data
- Further increase of model fidelity
Key Take Aways

Validation of grid models with a reference model
- is feasible and can be accepted in customer projects already
- helps enhancing grid model reliability early in projects
- Our goal: create awareness and broaden acceptance in the industry for the approach of validating grid models of wind turbines with reference models