



# New Validation Method for Models for Grid Studies

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**SENVION**  
wind energy solutions

# 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

- Validated grid models – how to get there
- Comparison between different validation methods
- Experiences with the new approach and outlook

## Who asks for validated models?

- Transmission System Operators (TSO)
- Clients of turbine manufacturers
- Certifiers
- Public authorities

## 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

## When are validated models needed?

- through all phases of turbine life-cycle

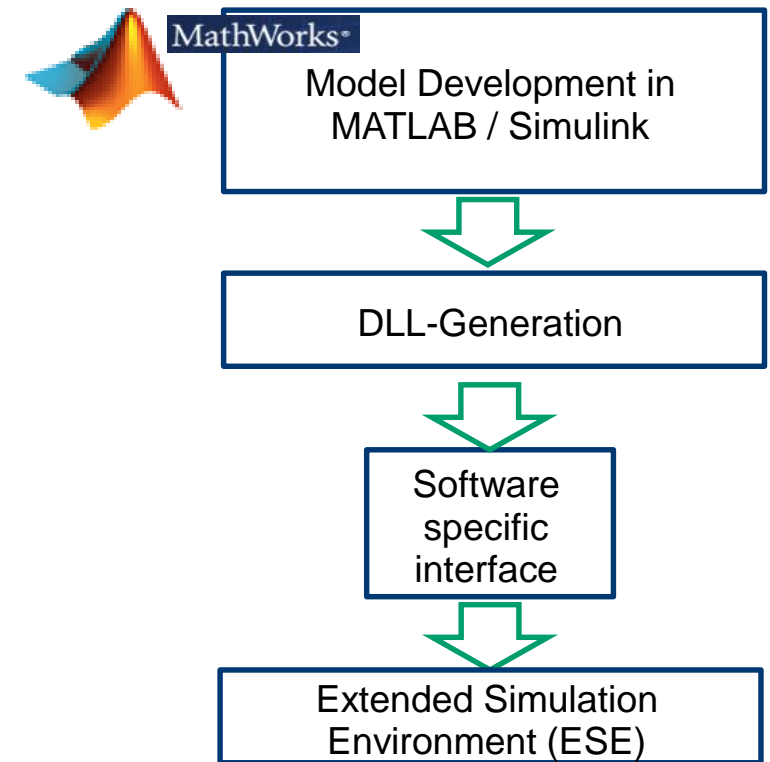
## What validation guidelines do exist?

- National, e.g. FGW TR4, TR8
- International, e.g. IEC 61400-27
- Project specific

# Customer Models for Grid Studies

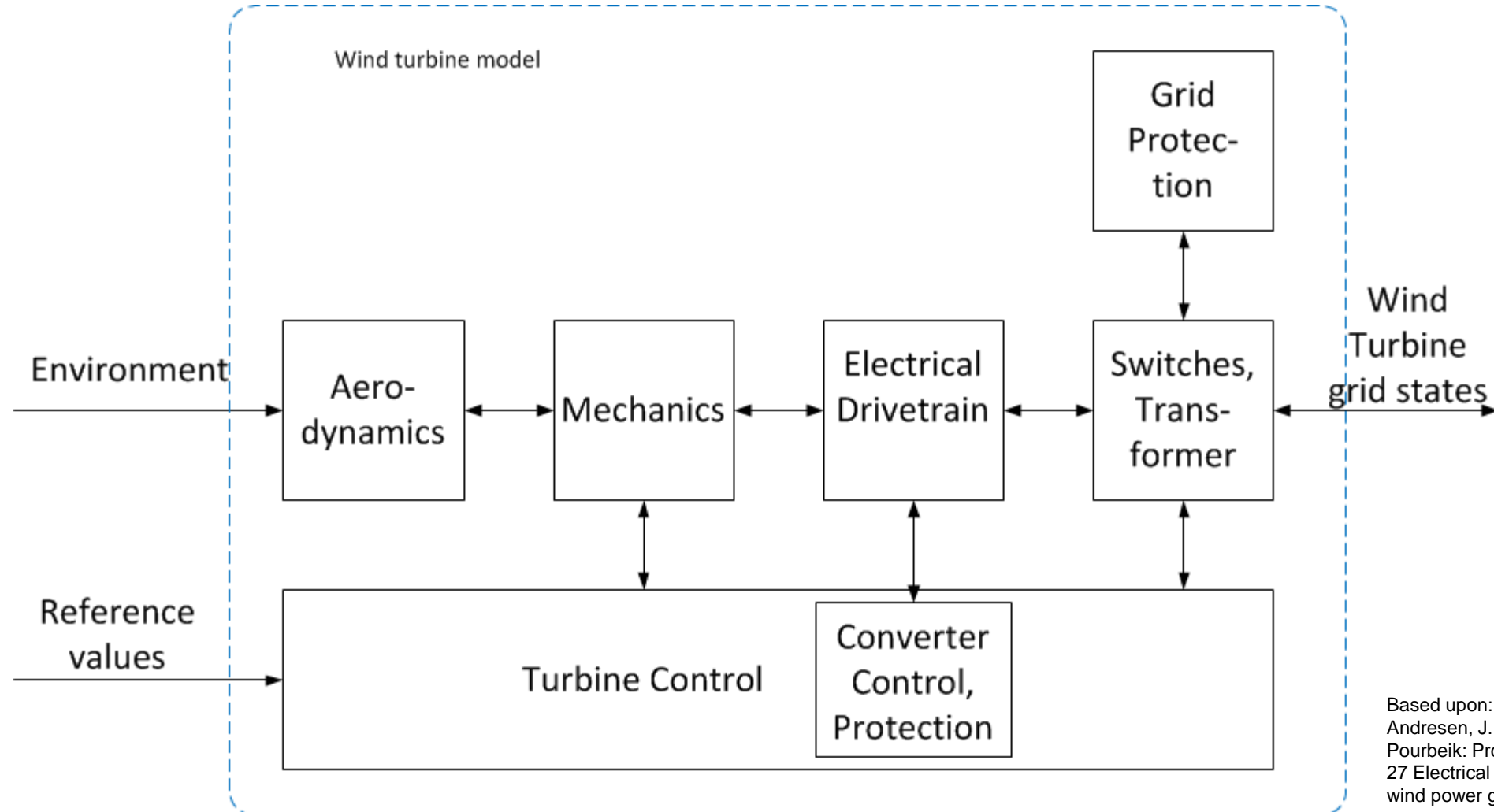
- Grid operators require **RMS** (root mean square) models of WTGs for grid studies
- Alternatively generic models can be used in some markets (WECC, IEC)
- For instantaneous value analyses **EMT** (electromagnetic transient) models are required

## Common Simulation Platforms:



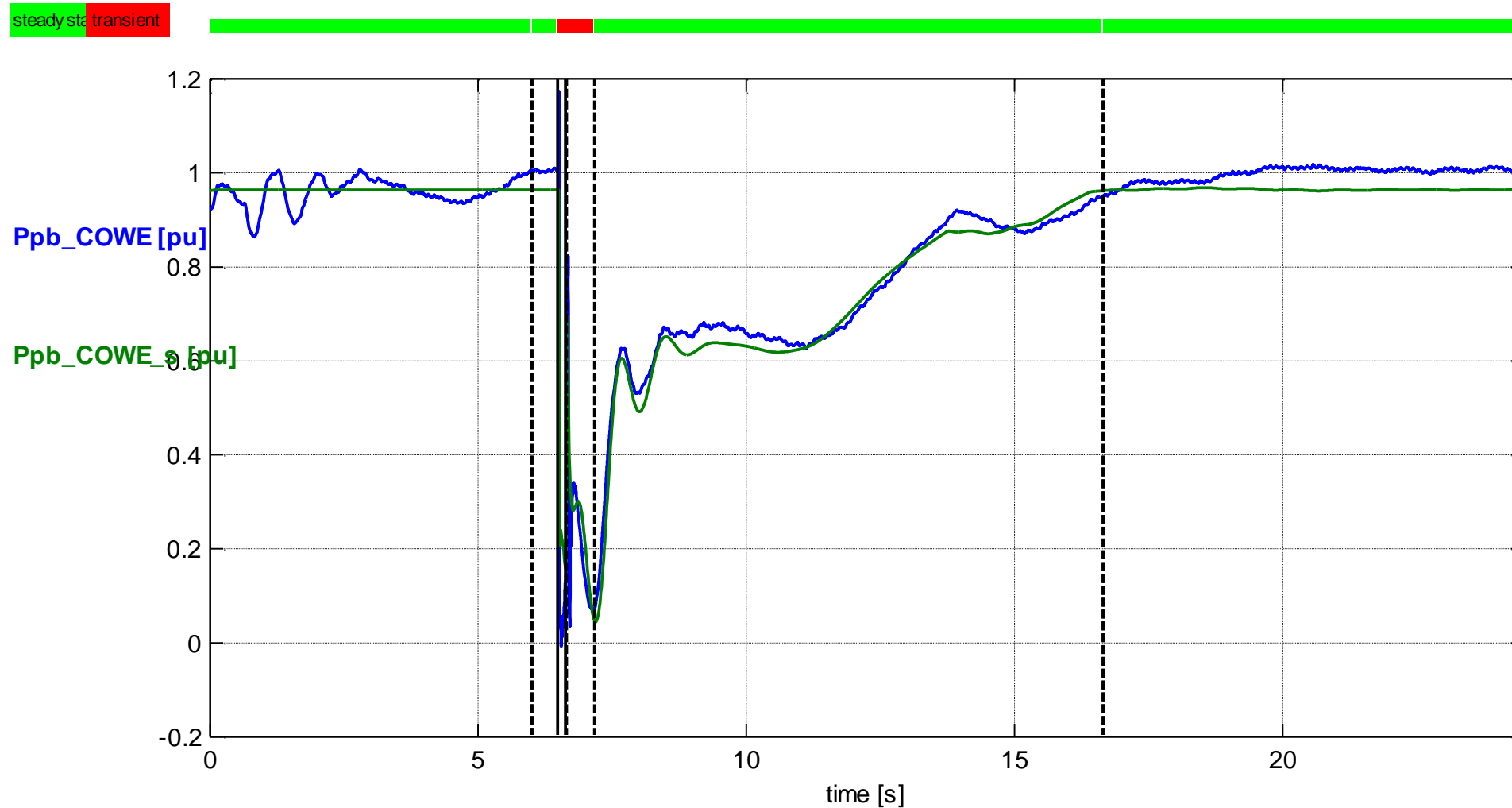
# Grid Model Subcomponents

Grid models describe grid relevant parts of windfarm components like turbines



Based upon: P.Sorensen, B. Andresen, J. Fortmann, P. Pourbeik: Progress in IEC 61400-27 Electrical simulation models for wind power generation

# Performing Model Validation



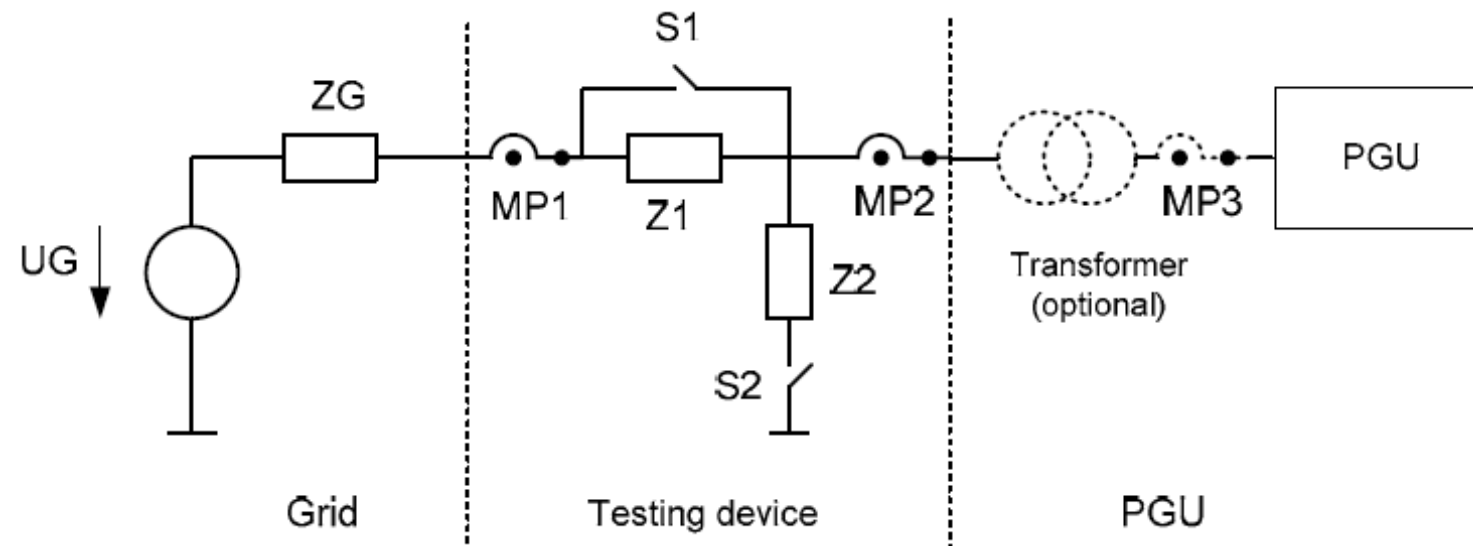
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# Traditional Approach to Gain Reference Data (1)

Fault Ride-Through (FRT) measurement with dedicated testing device (container)



Source: FGW, Technical Guidelines for Power Generating Units. Part 4 Demands on Modeling and Validating Simulation Models of the Electrical Characteristics of Power generation Units and Systems. Revision 5, March 3rd, 2010



## Advantages of measurements

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

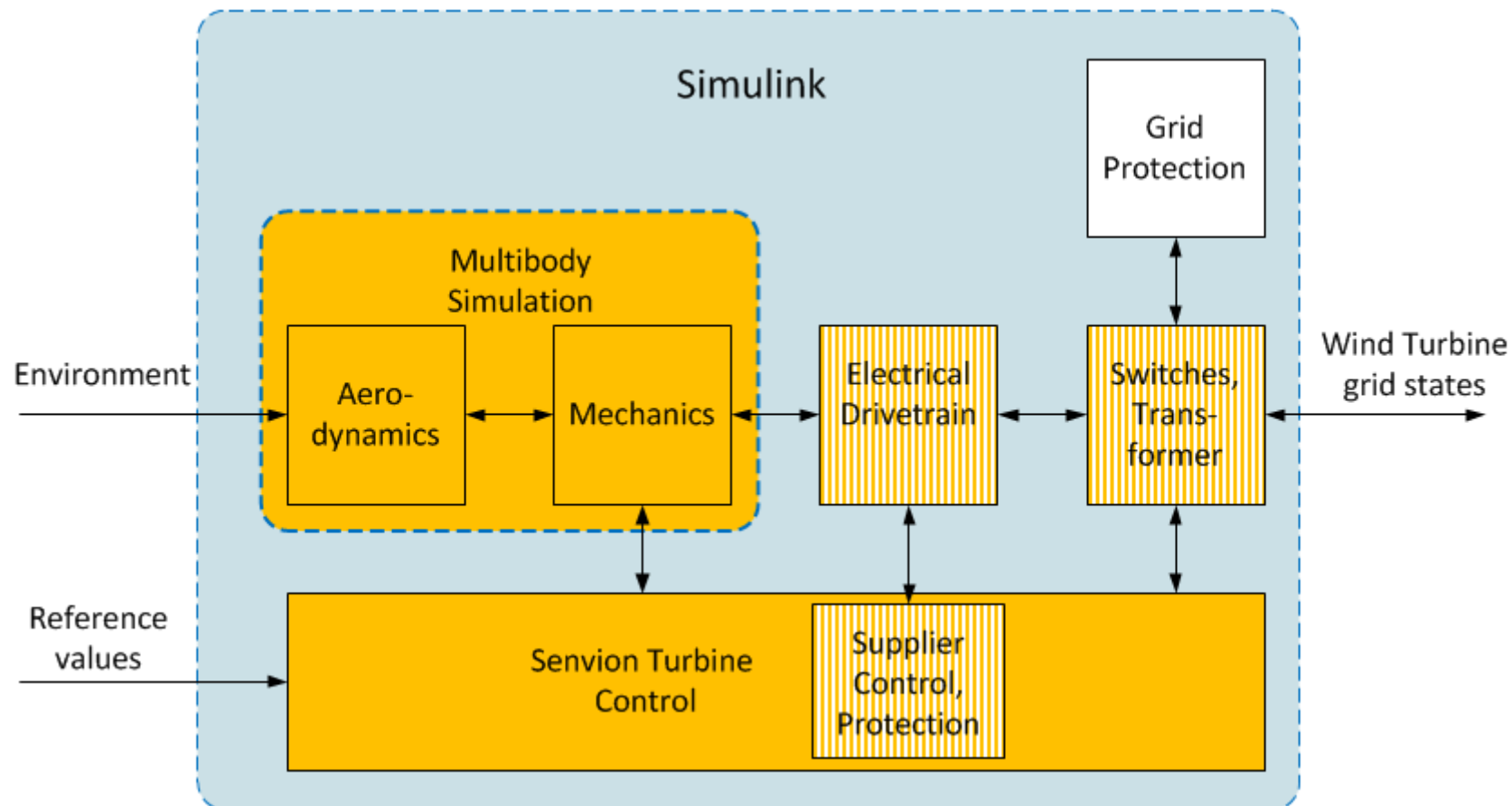
## Disadvantages of measurements

- 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



# Reference Model as Alternative to Gain Data (1)

- 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)

- Validated grid models – how to get there
- Comparison between different validation methods
- Experiences with the new approach 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

## 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



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