

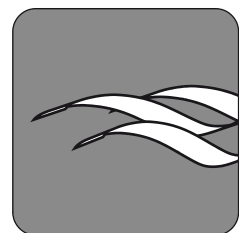
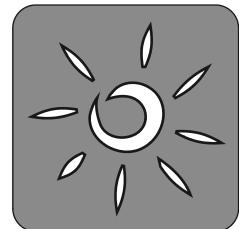
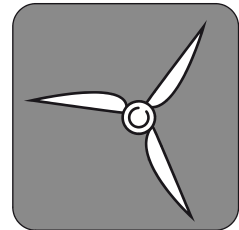
Technical Guidelines

for Power Generating Units and Systems

PART 4 (TG 4)

**Demands
on Modelling and Validating
Simulation Models
of the Electrical Characteristics
of Power Generating Units and Systems**

Revision 08
Dated 01/03/2016



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FGW e.V.
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In the interest of easier legibility, a gender-neutral differentiation is not used here. Any gender-specific terminology always refers to both genders.

The following parts of the FGW Technical Guidelines are available:

Part 1: Determination of Noise Emission Values

Part 2: Determination of Power Curves and Standardised Energy Yield

Part 3: Determination of the Electrical Characteristics of Power Generating Units and Systems in Medium-, High- and Extra-High Voltage Grids

Part 4: Demands on Modelling and Validating Simulation Models of the Electrical Characteristics of Power Generating Units and Systems

Part 5: Determination and Application of Reference Yield

Part 6: Determination of Wind Potential and Energy Yield

Part 7: Operation and Maintenance of Power Plants for Renewable Energy

Category A: Miscellaneous Section

Category B3: Specialist Application Notes for Monitoring and Testing Foundations and Supporting Structures for Wind Turbines

Category D2: State Event Cause Code for Power Generating Units (Zustands-Ereignis-Ursachen-Schlüssel, ZEUS)

Category D3: Global Service Protocol (GSP)

Category D3 – Attachment A: XML Schema Documentation

Part 8: Certification of the Electrical Characteristics of Power Generating Units and Systems in Medium-, High- and Extra-High Voltage Grids

Part 9: Determination of High Frequency Emissions from Renewable Power Generating Units

Foreword

The FGW's Technical Guidelines serve to aid in presenting measuring and testing methods allowing determination of reliable and comparable data for power generating units (PGUs) and power generating systems (PGS) based on state-of-the-art technology.

These guidelines describe the demands on modelling and validating simulation models of PGUs and PGS for describing the electrical characteristics on the grid.

A description of the methods for validation and modelling of the electrical response of PGUs and PGS in accordance with these Technical Guidelines serves to verify that the simulation models can model the electrical response of the PGUs and PGS with sufficient accuracy in terms of the measurements given in TG 3.

This guideline is an english translation of a prior german version. In any case of distinction between both revisions of TG 4 the german version is valid. In case of the use of non-gender neutral language, it is not the aim of the technical committee to discriminate against any gender.

Note: Text in italics must be clarified in TG 8 and can be dispensed with as soon as they are incorporated there.

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Abbreviations used

AC	Alternating Current
ADC	Analogue to Digital Converter
AR	Automatic reconnection in overhead lines following grid faults
AS	Auxiliary load
ASM	Asynchronous machine
AVR	Automatic voltage regulator
BB	Busbar
BDEW	Bundesverband der Energie- und Wasserwirtschaft e.V. (German Association for Energy and Water Supply)
BDEW MV guideline	BDEW medium-voltage guideline 'Generating plants connected to the medium-voltage network' [1]
BNetzA	Federal Network Agency
CCPP	Combined cycle power plant
CE	Combustion engines
CGP	Cogeneration plant: PGU with combustion engine, from which both electrical and thermal energy are utilised.
CISPR	Comité International Spécial Des Perturbations Radioélectriques
COM	Commissioning
DASM	Double-fed asynchronous machine
DC	Direct Current
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardisation)
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Sources Act)
EGD	Equivalent grid documentation
EHV	Extra-high voltage grid)
EMC	Electromagnetic compatibility
EN	European norm/standard
FACTS	Flexible Alternating Current Transmission System
FGW	FGW e.V. - Fördergesellschaft Windenergie und andere Erneuerbare Energien
FNN	Forum network technology/network operation in the VDE
FPC	Frequency-directed power controller
GCP	Grid connection point: the point at which the system is connected to the grid of the grid operator
GCR	Grid connection regulations
GENSET	Combination of generator and prime mover
GO	Grid operator

GSC	Generator sign convention
GT	Gas turbine
HC	Harmonic current
HS	Hydropower station
HV grid	High-voltage grid
IEC	International Electrotechnical Commission
IGBT	Insolated Gate Bipolar Transistors
ISO	International Organization for Standardization
LSC	Load sign convention
LV	Low voltage
LVRT	Low voltage ride-through
MAE	Mean absolute error between simulation and measurement [2]
ME	Mean error between simulation and measurement [2]
MOSFET	MetalOxide Semiconductor Field-Effect Transistor
MPP	Maximum Power Point (solar modules are normally operated at the point of maximum performance).
MV	Medium voltage
MV grid	Medium-voltage grid
MXE	Maximum error between simulation and measurement [2]
OEL	Overexcitation limiter
PC	Power controller
PCC	Point of common coupling: the point at which the system is connected to the grid of the grid operator (definition in accordance with SDL-WindV)
PCSR	Primary controller stability reserve
PGS	Power generating system: one or more PGUs including all electrical installations necessary for connection and operation, in accordance with BDEW MV guideline.
PGU	Power generating unit, individual unit for generating electrical energy, in accordance with BDEW MV guideline.
PSS	Power system stabilizer
PVS	Photovoltaic system: the PVS consists of modules that provide a DC voltage as a function of solar radiation, and the balance of system (BoS) components, including the inverter. Feed-in is always via an inverter. The inverter converts the PVS supply to a load-independent supply. The inverter is decisive for metering.
SDLWindV	Ordinance on System Services by Wind Energy Plants (Verordnung zu Systemdienstleistungen durch Windenergieanlagen)
SPS	Steam power station
ST	Steam turbine
STATCOM	Static Synchronous Compensator

SVC	Static VAR Compensator
TC 2007	Transmission Code 2007 [3]
TCC	Technical Connection Conditions
TG	Technical Guidelines
TG 3	Technical Guidelines 3 by FGW [4]
TG 8	Technical Guidelines 8 by FGW [5]
THC	Total Harmonic Current Distortion
TS	Transformer substation
UEL	Underexcitation limiter
VDE FNN	Forum network technology / network operation in the VDE (FNN)
VDN	Association of German Power Transmission System Operators (Verband der Netzbetreiber e.V.)
WaTu	Water turbine
WT	Wind turbine
ZVEI	German Electrical and Electronic Manufacturers' Association