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Overview

Existing requirements in Germany

> BDEW Technical Guideline Generating Plants Connected to the Medium-Voltage Network
  > background, references, requirements
  > lessons learned

Upcoming codes on the European level

> ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators
  > summary of the ENTSO-E interconnection requirements
  > lessons learned thus far as to how such a process should be undertaken

Summary
Existing requirements in Germany

BDEW Technical **Guideline Generating Plants Connected to the Medium-Voltage Network**

**background and history:**

> draft and publication by the German association of grid operators (BDEW)

> consultation of PV-industry as "junior partners"

> additional transitional periods had to be defined in **three amendments**
Existing requirements in Germany

BDEW Technical Guideline Generating Plants Connected to the Medium-Voltage Network refers to other guidelines, such as:

> **TransmissionCode 2007**
  for the definition of dynamic grid support

> **FGW-TR3** (Technical Guidelines Part 3)
  for the determination of electrical characteristics

> **FGW-TR4** (Technical Guidelines Part 4)
  for the modeling and validation of simulation models of the electrical characteristics

> **FWG-TR8** (Technical Guidelines Part 8)
  for the certification of electrical characteristics

... of power generating units and systems in medium and high voltage grids
Existing requirements in Germany

BDEW Technical Guideline Generating Plants Connected to the Medium-Voltage Network

requirements:

> **generation control** – i.e. power curtailment on demand

> **frequency control** – by reducing active power in the event of over frequency

> **voltage control** – by use reactive power

> **dynamic grid support** – with the option to provide reactive current to diminish voltage dips (AKA: “fault ride through” (FRT) / “low voltage ride through” (LVRT) / “zero power mode”)

> **certification** of

  > “units” (e.g. PV inverters) based on type testing and

  > plants (as a combination of one or more “units” and further equipment i.e. transformers, cables, etc.) based on simulation
Existing requirements in Germany

BDEW Technical Guideline Generating Plants Connected to the Medium-Voltage Network

Lessons learned (from a manufacturer’s and test institute’s perspective)

Suggestions for changes of the requirements:

> use of a **continuous function for frequency control**
  
  (i.e. $P(f)$ static instead of currently discontinuous function with hysteresis)
> definition of maximum and **minimum time limits for system response**
Existing requirements in Germany

**BDEW Technical Guideline Generating Plants Connected to the Medium-Voltage Network**

**Lessons learned (from a manufacturer's and test institute’s perspective)**

Suggestions for the improvement of the process for the creation of new codes:

> all stakeholders (TCOs, DSOs, utilities, manufacturers, certifying bodies, test institutes, project developers, ...) should be included in an early stage to pay tribute to significant differences in technologies (wind, PV, ... , transmission, distribution, ...)

> include references to international standards (and push for their update!) to avoid parallel or even conflicting requirements

> definition of reasonable transitional periods

> for the implementation of new requirements into new and existing product lines

be aware: retroactive requirements for existing equipment carry a high cost factor

> for the definition and implementation of the necessary infrastructure and processes e.g. for type testing and certification

> to allow for training of affected parties (project developers, utilities, ...)

Overview | Existing requirements in Germany | Upcoming codes on the European level | Summary
Upcoming codes on the European level

ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators (NC RFG)

history and timeline:

> **23 March 2011**: Publication of informal draft pilot code
> **20 July 2011**: ACER (European Agency for the cooperation of the Energy Regulators) publishes Framework Guidelines (FG) on Electricity Grid Connection
> **29 July 2011**: The European Commission officially requested ENTSO-E to draft this network code
> **02 November 2011**: Publication of working draft
> **24 January 2012**: Publication of draft for public consultation
> **24 January - 20 March 2012**: Web based public consultation on the Network Code with over 6000 comments on the draft NC RFG received
> **15 February 2012**: Public stakeholder consultation workshop in Brussels
> **End of June 2012**: Evaluation of comments & approval of the final code for submission to ACER
> **... to be legally binding in 2017!**
Upcoming codes on the European level

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Upcoming codes on the European level

ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators

represents a basis for an upcoming EU directive

> to provide regulation on cross border issues, currently covering
  > frequency control
  > system stability and security of supply issues on the European level

  remark: in the current version many requirements were included as “cross border issues”
  (such as very wide requirements for reactive power for voltage control)

> as a legal framework for local / national grid codes
Upcoming codes on the European level

**ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators**

summary of the ENTSO-E interconnection requirements

> four classes of Generating Units: A, B, C, D – defined by power level and voltage level

### Graded approach on significance

Network Code prescribes max. thresholds at synchronous area level
- Criteria based on MW capacity and voltage level thresholds (see table)
- Decision at national level, in line with existing legal framework

<table>
<thead>
<tr>
<th>Synchronous Area</th>
<th>maximum capacity threshold from which on a Generating Unit is of Type B</th>
<th>maximum capacity threshold from which on a Generating Unit is of Type C</th>
<th>maximum capacity threshold from which on a Generating Unit is of Type D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continental Europe</td>
<td>1 MW</td>
<td>50 MW</td>
<td>75 MW</td>
</tr>
<tr>
<td>Nordic</td>
<td>1.5 MW</td>
<td>10 MW</td>
<td>30 MW</td>
</tr>
<tr>
<td>Great Britain</td>
<td>1 MW</td>
<td>10 MW</td>
<td>30 MW</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.1 MW</td>
<td>5 MW</td>
<td>10 MW</td>
</tr>
<tr>
<td>Baltic</td>
<td>0.1 MW</td>
<td>and</td>
<td>and</td>
</tr>
<tr>
<td>Voltage level</td>
<td>&lt; 110 kV</td>
<td>&lt; 110 kV</td>
<td>≥ 110 kV</td>
</tr>
</tbody>
</table>
**Upcoming codes on the European level**

**ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators**

Summary of the ENTSO-E interconnection requirements

- Requirements depend on classification of Generating Unit

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### Frequency stability
**Graded approach in requirements**

<table>
<thead>
<tr>
<th>General requirements</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Type D</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQUENCY RANGES</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>LIMITED FREQUENCY SENSITIVE MODE (OVERFREQUENCY)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>RATE OF CHANGE OF FREQUENCY WITHSTAND CAPABILITY</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>REMOTE SWITCH ON/OFF</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACTIVE POWER REDUCTION</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>ACTIVE POWER CONTROLLABILITY AND CONTROL RANGE</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>DISCONNECTION DUE TO UNDERFREQUENCY</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>FREQUENCY RESTORATION CONTROL</td>
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<tr>
<td>FREQUENCY SENSITIVE MODE</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>INERTIA</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>LIMITED FREQUENCY SENSITIVE MODE (UNDERFREQUENCY)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>MONITORING OF FREQUENCY RESPONSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Synchronous Generator requirements

- CONSTANT OUTPUT AT TARGET ACTIVE POWER
- MAXIMUM POWER REDUCTION AT UNDERFREQUENCY

### Power Park Module requirements

- SYNTHETIC INERTIAL CAPABILITY
Upcoming codes on the European level

ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators

things to know (from a manufacturer's and test institute’s perspective):

> a lengthy process will eventually lead to a technical EU directive, but with legislative focus
> as a EU directive this document will be hard to adjust to new and upcoming system needs
> and thus will need to leave plenty of room for local interpretation and additional requirements
> focus is on classical power generation based on electrical machines and less on inverter based generation

things to improve (from a manufacturer's and test institute’s perspective):

> Harmonization of requirements and references to international standards
  (push for update of existing standards instead of creating parallel structures)
> Allow flexibility for adjustment to new and upcoming system needs (e.g. 50.2 Hz problem)
> Harmonized requirements for type testing, modeling (generic models), and certification
> Harmonized requirements for system communication (e.g. IEC 61850, DNP3)
Summary

BDEW

Technical Guideline Generating Plants Connected to the Medium-Voltage Network

> many relevant documents and associated high complexity of processes

> relevant stakeholders were included at a very late stage

> differences in technologies were not sufficiently accounted for, leading to unclear requirements

> transitional periods were too short and had to be readjusted several times

ENTSO-E

Draft Network Code for Requirements for Grid Connection applicable to all Generators

> long way to go

> will most likely not provide the desired harmonization of requirements which would eventually bring down cost and complexity

> short and medium term systems needs will still have to be dealt with on a local / national level
Tank you for your attention

... and remember:

Think big!

Renewables develop very fast. Don’t do small solutions!

The crucial questions is:

“How can we control a grid with 100% inverter based generation?”
Resources

> **BDEW Technical Guideline Generating Plants Connected to the Medium-Voltage Network**

> **ENTSO-E Draft Network Code for Requirements for Grid Connection applicable to all Generators**
  [https://www.entsoe.eu/resources/network-codes/requirements-for-generators/](https://www.entsoe.eu/resources/network-codes/requirements-for-generators/)


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