DER certification

Words: Bernd Hinzer, Principal Engineer and Head of Section Grid Code Compliance and Tobias Gehlhaar Principal Engineer, DNV GL

Utility grid interconnection requirements for distributed generation, including solar, have been evolving to support higher levels of penetration. The new requirement that Distributed Energy Resources (DERs) have to meet according to IEEE 1547 requires verification that the DER asset is compliant to this new standard. This article describes DNV GL's 3-step approach, which ensures verification and can contribute to a more cost effective project and provide long-term benefits.

Bernd Hinzer

Tobias Gehlhaar

Distributed Energy Resources (DER) can put stress on the power grid [8]. Interconnection requirements for improving electrical reliability have been well known for a long time and DNV GL has worked in the implementation of these for many years. A good number of new requirements have been developed over time [1]. DNV GL refers to these official documents as "grid codes" whether they are laws, orders, standards, or any other document that identifies requirements for safe and utility supportive integration of DER to the power grid. Regional rules for interconnection and interoperability of DER are also routinely identified and these also require DER compliance. These grid codes are evolving. New regulations come up and they have to be implemented. This often happens cross-regionally in order to handle the increasing amount of DER generators connected to the electrical power grid.

In the United States, a new draft of the next revision of IEEE 1547 has been communicated (working title: "P1547/D4.0, May 2016, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces") [4]. Finalisation of this standard is expected in 2017. The corresponding test standard, IEEE P1547.1 is being revised consequently and the finalisation is expected in 2018/2019. IEEE 1547 defines three technology-neutral categories of performance for DER, powered by wind, powered by solar, and powered by biogas or water, as well as, being connected to storage systems.

The locally relevant performance category according to IEEE 1547 will be defined based on attributes such as technology, application purpose, and specific characteristics of power grid (a set of requirements that specify technical capabilities and settings for a DER).

Based upon the chosen category, a DER will have to be compliant with specific interconnection and interoperability requirements. Therefore testing, verification and certification procedures have to be offered to be used in the market. A state-of-the-art designed DER must be able to support the EPS with ancillary services (e.g. active and reactive power generation) during normal operation, as well as during electrical faults in the electric power system (e.g. during LVRT and HVRT, see example in Figure 2). Amongst other requirements, this obligation has to be taken into consideration during design, planning and negotiating interconnection agreements for new DER facilities with the utility.

To verify the fulfilment of these new requirements, testing specifications must be defined. The IEEE P1547 draft [4] only gives high-level specifications for tests for short circuit behaviour and more detailed test specifications and procedures will be defined in the dedicated testing standard IEEE P1547.1. Variation of voltage dip depth during hardware testing is state-of-the-art according to other test standards like DNV GL-SE-0124 [2] or DNV GL-ST-0125 [3], and corresponding testing equipment [5] is available to perform such testing with voltage drops down to different voltage

levels and under full load or partial load. Drafting of IEEE P1547.1 has begun and should coordinate with existing test standards like [3]. A typical test set-up for such testing can be seen in [3], as shown in below Figure 3.

The tests according to [3] are performed for three voltage levels and for two durations with two loading levels as 3-phase voltage dips and as 2-phase voltage dips. The duration is set by using the switching commands of switch S2. Z2 which can be set variably and will lead to voltage levels which can be set as needed for testing specific grid code requirements. Such requirements can be interconnection system default response to abnormal voltage, the so called voltage Ride-Through requirements as shown in Figure 2.

A corresponding verification is important for advising, consulting, planning and insuring companies, as well as for banks, lenders, owners, and for operators of DER facilities and utilities (operators of EPS). In order to reduce the risk of operating problems, such investigations should be based on hardware testing including voltage drops down to different residual voltage levels. It is not enough to perform only simulations using unvalidated simulation models. Validating models against LVRT and HVRT test results is possible. This is part of DNV GL's services and validation standards exist. Proof of validation to these requirements should be included in the interconnection agreements in order to improve national electric reliability. As this task of proof and independent verification is repeated frequently, the use of a certification system should be considered for IEEE 1547 [4].

There is a growing demand for services of testing, verification and certification of interconnection and interoperability requirements.

The global approach of these services is intended to help in determining which requirements are to be taken from IEEE 1547 [4] (or similar parallel requirements), how to provide evidence of compliance by testing and measuring technical capabilities of types and plants, and how to evaluate the results and keep them compliant with certain requirements at different levels.

As the verification methodology remains to be specified in IEEE P1547.1 and there may be a transition period with lack of clarity, DNV GL offers the international service specification DNVGL-SE-0124 [2] which can

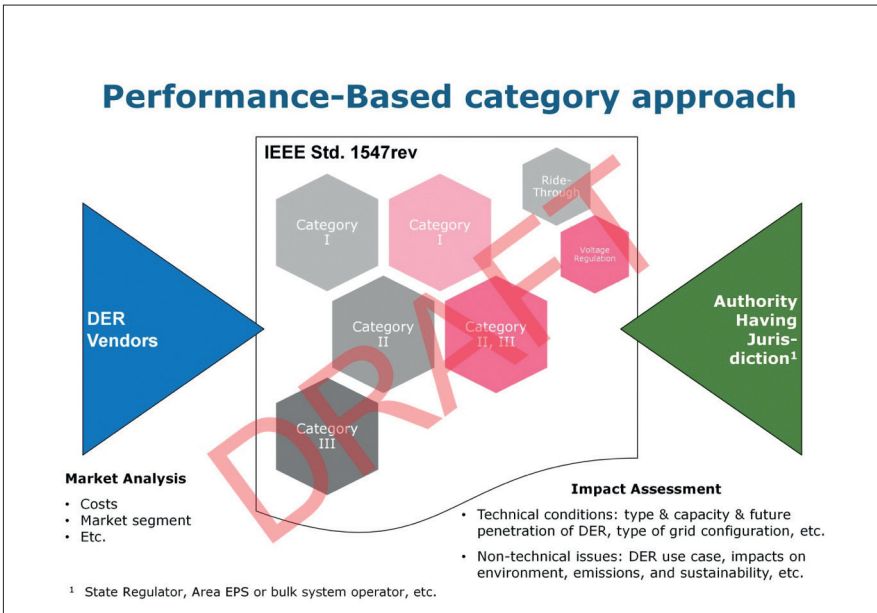

Figure 1: High-level overview of performance-based category approach [4], Source: IEEE-draft and [6,7]

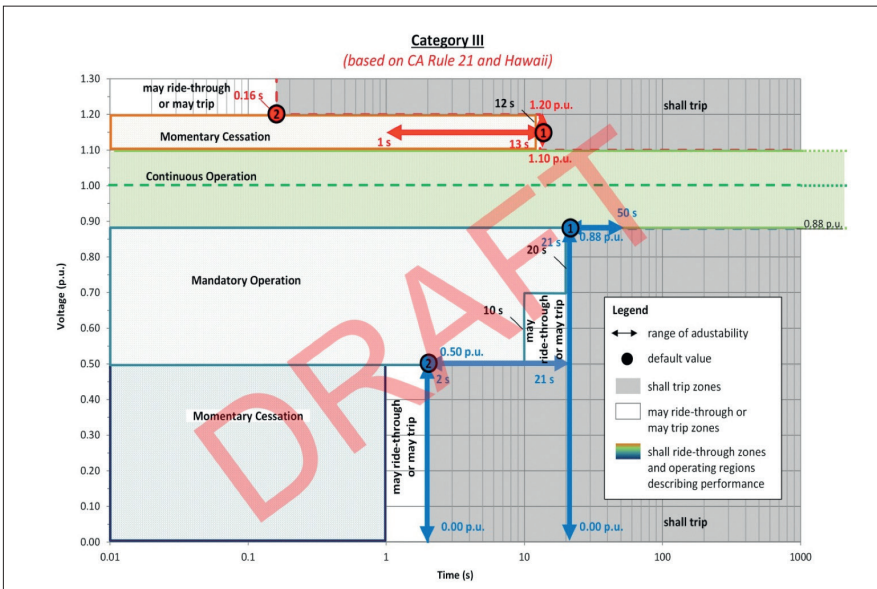

Figure 2: Interconnection system default response to abnormal voltage and voltage Ride-Through requirements for DER of Category III [4], Source: IEEE-draft and [6,7]

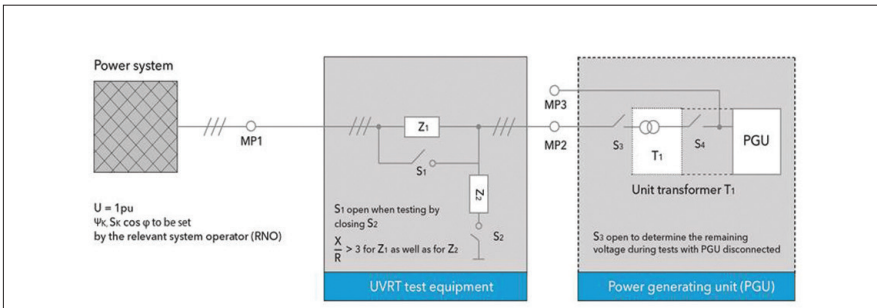

Figure 3: Hardware test set-up for low-voltage ride-through test equipment, full power [3], Source: DNV GL

be used. To avoid misunderstandings, in DNVGL-SE-0124 [2] all verification steps are well-defined; however, definition of requirements is not given here as they are nationally or regionally different. Using this service specification helps each stakeholder in his own area to independently prove fulfilling all requirements.

Usually types of power generating DER are sold in multiple global regions with different grid interconnection requirements. For those that required it, a "multi-national approach" can cover several sets of requirements with one test and one type certificate. In the United States, not only IEEE 1547 is relevant, but also NERC rules, resulting in requirements such the following:

- Reactive power and voltage control
- Performance during and after disturbances
- Active power control
- Harmonics and subsynchronous interactions
- Models for facility interconnection studies
- Communications between plants and operators

For other markets additional requirements can also be expected, see [1].

The Service Specification DNVGL-SE-0124 [2] describes a structured way to prove the fulfilment of interconnection and interoperability requirements for DER, divided into generating unit type (type certificate) and generating plant (project certificate). This is because type testing of DER does not need to be repeated for each project as well interconnection agreement. Independent proof can easily be confirmed by a corresponding type certificate according to the service specification [2]. However, no generating plant should get a power purchase agreement without having proven that all equipment used within the plant have successfully passed the tests related to IEEE 1547 performance category, and the plant as a whole is compliant which can be proved by a project certificate according to the service specification [2].

The simple approach of the service specification [2] is divided into 3 phases: Definition phase, Verification phase, and Certification phase.

For foreign countries a pre-screening investigation of relevant rules and requirements may be helpful.

Definition phase

- Investigating grid code requirement
- Defining assessment scope

Pre-screening report

Grid code requirements

Figure 4: Definition Phase [2], Source: DNV GL

Verification phase

- Test plan preparation
- Modelling simulation models
- Performing tests according to test plan and preparing test report with measurement results
- Evaluating measurement results based on defined assessment scope
- Validating simulation models

Test plan

Simulation plan

Test report
(determination of electrical characteristics)

Certification report (CR)
Different CR's

Figure 5: Verification Phase [2], Source: DNV GL

Certification phase

- Finally assessing verification
- Stating conformity according to service specification and based on success criteria according to defined assessment scope
- Issuing certificates

Certificate

Different certificates

Statement of compliance (SoC)

Different SoC

Figure 6: Possible reports in certification phase according DNV GL SE-0124 [2], Source: DNV GL

The first step (definition phase) includes assignment of the relevant country and the grid code, as well as the verification level which sets the scope of project according to the service specification [2]. The verification level is divided into three classes.

Class I: finally approved by system operator to be used in his gridClass II: evaluated according to service specification [2] and found to fulfil interconnection requirement

No class: test and report according to the maximum capability approach

The verification level can be set individually for each certification.

However, know-how is growing about which class can be recommended to be assigned for which country in the world. Currently class I or II seem reasonable to follow IEEE 1547 [4] and therefore be implementable in the United States. The performance categories of IEEE 1547 [4] will be another issue to be assigned during the definition phase.

The second phase, the verification phase, includes testing. For this, the level and scope of testing has to be defined, which is done as a test plan preparation. This can be done for the requirements of IEEE 1547 [4] or for multiple countries (based on multi-national sales approach of manufacturer of DER), resulting in less testing.

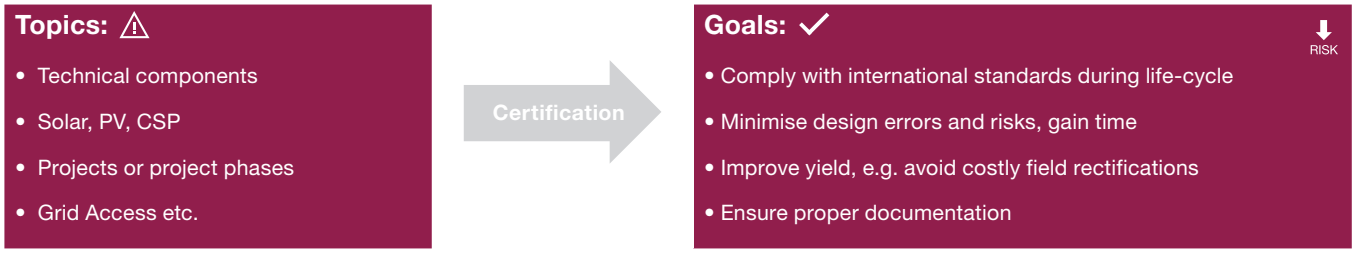

Figure 7: Benefits of test, verification and certification for stakeholder according DNV GL SE-0124 [2], Source: DNV GL

Manufacturers of DER generating unit types can have proof of evidence independent from any local requirement, with a scope defined in the definition phase. This should be done according to the listing of possible verification features from the Appendix of the Standard DNV GL-ST-0125 [3] (e.g. frequency control or reactive power control only).

All stakeholders of DER plants (projects) will benefit if they see their individual requirements met. This is possible when requiring the strongest class I for a project certificate (PCI) according to the local demands as given in IEEE 1547 [4] supported by DNV GL SE-0124 [2] and DNV GL SE-0125 [3]..

Equipment manufacturers can benefit by asking for an Equipment Certificate in class II, covering many countries and local requirements, and taking into account a standardised but limited scope. This scope is the intersecting area between the grid code applied (e.g. IEEE 1547 [4] and NERC) and the service specification itself.

- Statement of Compliance (SoC)
- Component Certificate (CC)
- Equipment Certificate (EC)
- Type Certificate (TC)
- Project Certificate (PC)
- Compliance Monitoring Service

This 3-step approach offers a variety of possible services by keeping things easy to understand, keeping results valuable and decreasing risk inside the project.Type-Certified DER offer an easier global selling possibility without separate permission processes within each regional area of interest. At project area everything will be approved ahead the commissioning, to avoid time consuming and money wasting tests on site. By using this approach the yield of projects will increase considerably.

"All stakeholders of DER plants (projects) will benefit if they see their individual requirements met"

Type certificates and project certificates for grid code requirements all over the worldare feasible and welcome at stakeholder (Figure 8). Type Certificates (TC) and Project Certificates (PC) will provide independent proof of evidence regarding the set of interconnection requirements e.g. in IEEE 1547 [4] for each stakeholder while precisely documenting the ability of the DER type or plant.

Stakeholder interested in the services, should call the most experienced and by German Government (DAkkS) endorsed neutral expert to let them confirm that their investment is safe, sound, and fit for purpose. NV GL Renewables Certification experts know all major manufacturers of DER, know more than 1000 German Wind, PV and CHP farms (capacity from 1 MW upto 400 MW), as well as a lot of industry projects with a capacity of more than 50MW per generator, having done testing, verification and certification within these areas.

A renewable energy generating plant (RES) is a DER "system of systems" with a high complexity. The sooner a neutral expert is involved in the project processes, the more efficient the project will run; costs are reduced during the entire project lifetime.

A cooperation with independent experts to proof the compliance of DER according mandatory Interconnection Requirements as in IEEE 1547 [4], makes each stakeholder more competitive. Using the services according DNV GL SE-0124 [2] and DNV GL

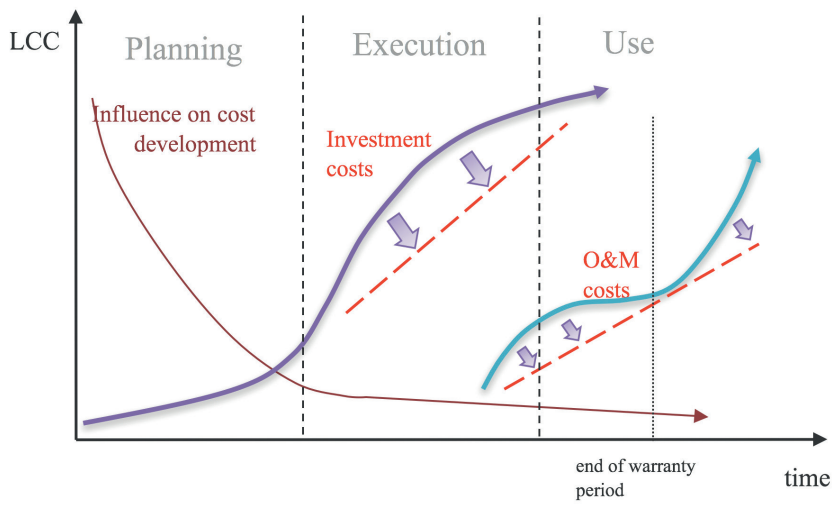

Figure 9: Influence of test, verification and certification to lifetime costs, Source: DNV GL

Figure 8: Stakeholders that benefit from test, verification and certification services, Source: DNV GL

SE-0125 [3] will close gaps in standards and interpretation will manage and check complex interfaces by seeing that each DER has technical innovations. The independent expert is doing more than the minimum standard, will help each stakeholder to ensure risk reduction and increase bankability for each Distributed Energy Resource. ■

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References:

[1] link: www.dnvgl.com/GridCode Listing.pdf

[2] link: http://rules.dnvgl.com/docs/pdf/DNVGL/SE/2016-03/DNVGL-SE-0124.pdf

[3] link: http://rules.dnvgl.com/docs/pdf/DNVGL/ST/2016-03/DNVGL-ST-0125.pdf

[4] P1547™/D4.0 Draft Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, May 2016

[5] Voltage dip test equipment can be rented from DNV GL:

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[6] IEEE Response to FERC NOPR RM16-8: http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20160524-5055

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