EMPIR Call 2020 – Fundamental, Industry and Normative

Selected Research Topic number: **SRT-n09**
Version: 1.0

Title: Extended testing for Renewable Generation under the Requirement for Generators Directive

Abstract

Disturbances on the electricity grid can cause the power converters used in renewables to malfunction causing a sudden disconnection of generators. This can lead to a cascade of failures resulting in widespread power outage. The EU directive on the Requirements for Generators (RfG) calls for compliance testing to ensure generators are immune to disturbances, but the adequacy of these regulations has been challenged by the increased use of renewables. To ensure a stable and secure energy supply, CENELEC NEC TC8X have called for new standard tests based on actual grid connections, together with on-site testing of generators, to assure the resilience of renewables and storage farms when they are exposed to grid disturbances.

Keywords

Renewable generation, electricity grids, power quality (PQ), type approval testing, power system reliability, Requirements for Generators.

Background to the Metrological Challenges

The ever-increasing domination of renewable generation is changing the grid environment and vulnerabilities of renewable controllers to abnormal disturbances poses a constant threat of blackouts. To resolve this situation, utilities and renewable manufacturers need clear testing procedures for renewable convertors. Currently, the information is scattered in different specifications and grid codes covering different technologies and regions. There is a need to conduct a gap and inconstancy analysis of the various existing methods and specifications which will result in clear testing requirements and measurement methods for renewables.

Furthermore, as renewables replace traditional generation, the resilience of the grid reduces and there is an emergence of new types of disturbances, which were not included in the original RfG testing regime. As a result, generators do not have assured immunity to these new types of disturbances, and they are therefore vulnerable to malfunction and sudden disconnection.

Related to this is the need to understand how these grid disturbances affect the stable operation of renewable generators. The disturbances that are likely to cause power convertors to malfunction need to be identified, so that new testing scenarios can be designed to ensure immunity to these disturbances. As the power convertors have an algorithm at their core, simulations of various convertor control loops when exposed to synthesised grid conditions can reveal vulnerabilities, thereby identifying challenging new testing conditions. Having identified new test conditions, new test rigs to carry out assessments of generator controllers are needed.

In order to assess the suitability of a new renewable generator connection to the grid, there is a collection of testing recommendations, grid codes, standards and procedures which could be applied. These include RfG testing and other immunity and functional testing of generators such as the functional testing of renewables to support the power system frequency under the frequency containment reserve as required to support EU regulations on energy balancing and other normative technical specifications.

Qualification testing of renewable generators does take place prior to grid connection, but manufacturers lack clarity as to which parameters that should be measured and the methods required to make a reliable assessment. This points to a clear standardisation gap as identified by CLC TC8X “system aspect of electrical energy supply”.

Renewable power convertors are known to react to grid disturbances and cause grid instabilities and there is a growing catalogue of recorded malfunction incidents, some of which have led to high profile power failures. The exact nature of the grid disturbances that have caused these instabilities remains unknown, as does the interaction of grid behaviour and grid disturbances with renewable controllers. It follows that the testing

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methods, the available test rigs, and measurement equipment are incomplete and need to be appropriately defined and specified, such that renewable generators can be approved against newly developed testing conditions and synthesised disturbances.

Whist the RfG met the needs of grids dominated by traditional synchronous generation, the RfG is not sufficient to ensure stability in future grids with significant levels of renewables which are more prone to disturbances. An updated normative testing protocol for renewables based on actual grid conditions is therefore required.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on metrology research necessary to support standardisation in the renewable generation of electricity grids under the Requirement for Generators Directive.

The specific objectives are

1. To analyse existing methods of RfG (normative, grid codes, directives, literature) to ensure that generators meet the RfG requirements under actual grid conditions. This includes specifying the parameters that need to be measured and requirements on the instruments and procedures to measure them.
2. To determine and catalogue the normal range of power system behaviour and the measurement parameters that influence the response of the renewable generator. Additionally, to catalogue abnormal disturbances that occur on the power grid, including an index for the severity of the disturbance and its frequency of occurrence.
3. To develop a power converter-grid model to (i) expose the converter to the grid behaviour and disturbances outlined in objective 2, and (ii) analyse the response of the converters to each disturbance type.
4. To design and develop test rigs to test grid converters in the laboratory exposing them to synthesised abnormal disturbances and capturing the response. This includes the development of new testing apparatus and associated metrology infrastructure for on-site generator assessment, demonstrating new RfG *in-situ* measurement methodologies through on-site measurement campaigns.
5. To facilitate the take up of methods and technology developed in the project by standards developing organisations such as CEN CLC TC8X and propose amendments to the EU Directive requirements for generators (RfG). To ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them (e.g. smart electricity grids), and in a form (e.g. Technical report) that can be incorporated into the standards at the earliest opportunity.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP and EMPIR projects 09ENG04 SmartGrid, ENG61 FutureGrid, 14IND08 ELPOW, 15RPT04 TracePQM, 16ENG04 MyRailS, 16ENG05 MICEV, 17NRM01 TrafoLoss, 17NRM02 MeterEMI, 18NRM05 SupraEMI, 19RPT01 QuantumPower and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.8 M€, and has defined an upper limit of 1.0 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the electricity grid sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.

Additional information

CEN/CENELEC identified this topic as part of their priorities. Details are available at:

https://msu.euramet.org/current_calls/pre_norm_2020/documents/cen_priority_010.pdf