Potential European Partnership on Metrology
Call 2021 – Green Deal and Normative

Selected Research Topic number: **SRT-v02**
Version: 1.1

Important information about these documents

This call is being held ahead of any agreement from the Commission that the relevant funding will be available. At present the relevant legislation is still under discussion in both Council and Parliament, and there is no certainty on the detailed arrangements for funding selected projects. The funding of any selected project, and the terms and conditions of participation in the projects, are dependent on completion of the legislative process and the subsequent contractual processes between the European Commission and EURAMET. Proposers submit to this call at their own risk.

Background

Last year, EURAMET submitted a draft proposal to the EC for a further research programme to be established under article 185 of the Treaty on the Functioning of the European Union (TFEU) to follow on from EMRP and EMPIR. This was published by the EC at https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/candidates-digital-industry-and-space_en

The initiative would be called the European Partnership on Metrology and would aim to create, by 2030, a sustainable and effective system for metrology at European level that ensures Europe has a world-class metrology system that:

- Provides metrology solutions, fundamental metrological reference data and methods, offering fit-for-purpose solutions supporting and stimulating European innovation and responding to societal challenges.
- Supports and enables effective design and implementation of regulation and standards that underpin public policies that address societal challenges.

The Commission commissioned an impact assessment into this proposal and 11 others in similar priority areas, and, based on those findings, published their own proposal for the Partnership, their response to the impact assessment and a draft of the Decision on 23rd February 2021. See:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:89:FIN

https://ec.europa.eu/commission/presscorner/detail/en/ip_21_702

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0035&qid=1614677899327

That draft Decision is currently under discussion in the European Council and the European Parliament.

Under the assumption that the Council and Parliament pass the basic act which would form the legal basis for this research programme, and that the participating countries named in the Draft Decision submit the required commitment letters, EURAMET is publishing these potential Selected Research Topics and draft guidance notes. These documents are not approved by the Commission nor will they lead to a binding decision by EURAMET e.V. for any further negotiation or funding. All published guides and templates are subject to amendment by the EC and EURAMET e.V. as further information becomes known.

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Title: Grid measurements to enable widescale renewable electricity generation

Abstract

The 2050 net-zero economy relies on continued growth in the connection of renewables to electricity grids, but this is limited by several bottlenecks. These include: (i) serious threats to frequency stability due to lack of inertia to absorb supply and demand fluctuations, (ii) risk of voltage collapse due to lower short-circuit currents during faults, (iii) false generator de-loading and infrastructure damage due to disturbances from renewables converters, and (iv) limited capacity of the grid to deliver increased power flows. These challenges require multi-disciplinary metrology to develop traceable measurement infrastructure that supports new control schemes for frequency and voltage stability, disturbances and dynamic capacity allocation for electricity grids to maximise the safe and stable connection of very high levels of renewable energy sources (RES) such as wind and solar generation, which are essential to achieve the EU 2050 net-zero emissions target.

Keywords

Energy transition, renewable energy sources, wind and solar generation, hosting capacity, electricity grids, grid stability, power system reliability, power system monitoring and control

Background to the Metrological Challenges

Renewable energy sources (RES) have fundamentally different characteristics from traditional generation, limiting their connection in a context of conventional grid operation. Crucially, distributed wind and solar generation are connected by power converters, which do not provide the same intrinsic grid stability as traditional rotating machines. The switching power electronics inside these converters introduce new disturbance phenomena to electricity grids, which previously required very few monitoring and tools. Moreover, RES such as offshore windfarms are often built in locations with weak grid connections and low power flow capacity. All these factors create a need for advanced grid observability and control to enable continued growth in renewables connected to electricity grids.

To maintain frequency stability during sudden supply and demand changes, grid inertia is essential. As the share of RES increases, inertia is decreasing, therefore the grid frequency becomes unstable, leading to increased faults, poor power quality, and blackouts. To prevent these problems, measurement and control of grid inertia is one of the most important issues facing grid operators in future energy scenarios, thus the need to establish verification through a metrological framework.

The increase in RES is also reducing the voltage stability of electricity grids. Converter-connected wind and solar generation do not have the capacity to feed short circuits with the same high-level currents as traditional synchronous generation, resulting in unacceptable voltage drops that can set off cascades of protection system trips, ultimately leading to customer disconnection. To mitigate low voltage stability, instrument manufacturers are developing innovative equipment for real-time measurement of short-circuit capacity (system strength). In a similar manner as for inertia measurement, metrological characterisation of these new instruments is still missing.

Stability challenges causes concern in industry about the incidence of new grid disturbances introduced by converter-connected RES. If left undetected and uncontrolled, some disturbances can trigger catastrophic faults for example the build-up of oscillatory interactions between the power converters used in renewable generators. To prevent power cuts, grid operators' early warning systems must be improved to detect anomalies and atypical behaviour associated with RES disturbances. These disturbances include superimposed current and voltage transients in the range of up to several tens of kHz, which also lead to faster aging and damage of insulation materials in grid components. An example is given by high-frequency vibrations occurring in solid-dielectric power transformers with the catastrophic result of transformer failure. Equipment manufacturers require traceability of medium-voltage measurement of disturbances to support the development of effective monitoring systems.

A further barrier to connection of RES are thermal limits on the power flow capacity of the grid. As high levels of renewables and electric vehicles are installed, parts of the grid are overloaded for short periods of supply and demand. Most existing grid assets such as overhead lines, cables and transformers do not have integrated sensors, but their temperature can be determined remotely using available electrical grid measurements and electrothermal measurement models or 'digital twins'. These models need to be improved and validated to the

level of accuracy required to dynamically allocate the grid capacity for short periods, allowing for the thermal ratings to be exceeded, reducing or removing the need for reinforcement.

While instrumentation implementing inertia measurement is under development and commercial offerings are emerging, accuracy and reliability of continuous inertia estimation techniques have not been adequately proven yet due to limited ground truth knowledge. New metrological methods and instrumentation for calibration must be established to verify the reliability of inertia measurements as control inputs to provide so-called synthetic inertia for frequency stability. Robustness to disturbing influences and fast responsiveness of underlying measurements of power system frequency and rate-of-change of frequency need to be ensured by building on the previous EMPIR project 15NRM05 ROCOF.

Similarly, commercial instruments for system strength (short-circuit capacity) measurement are appearing, but traceability and assessment in the presence of typical grid disturbances are lacking. Therefore, capability for laboratory and in-situ verification must be developed to create the foundations for interoperability and comparability of equipment to provide reliable inputs to voltage stability control schemes. Developments are needed to make a significant contribution to the activities of European system operators and feed into the deliberations of CENELEC and IEC to develop the necessary measurement and data-analysis techniques to control the smart grids. This will lead to improved product testing for development of interoperable power grid equipment and methods for condition monitoring of grid components, boosting Europe's power industry with a unique competitive advantage.

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 the traceable measurement and characterisation of infrastructure for electricity grids to maximise the safe and stable connection of renewable energy sources (RES).

The specific objectives are:

1. To develop new inertia measurement methods to establish traceability for emerging commercial instruments in the presence of disturbing influences in the grid. This includes the demonstration of these methods as prototype laboratory functional testing rigs and as reference instrumentation used on-site for reliable evaluation of grid frequency stability and verification of installed equipment with high levels of RES.
2. To develop "system strength" (short-circuit capacity) measurement methods to establish the traceability for emerging commercial instruments. To use these methods as prototype functional testing rigs and as reference instrumentation used on-site for reliable evaluation of grid voltage stability and verification of installed equipment with high levels of RES.
3. To develop data science methods and apply them to data sets of grid measurements for the detection of abnormal system conditions, correlating disturbances-of-concern to the operation of RES. To determine the bandwidth required to measure disturbances-of-concern and establish traceability for the measurement of these disturbance at medium voltage levels (> 1 kV).
4. To improve and validate electrothermal models of grid assets using traceable electrical and thermal measurements of the assets in laboratory and field tests. This includes enabling the remote real-time temperature measurement of stressed grid assets such as overhead lines, cables and transformers to calculate dynamic thermal ratings to safely increase power flow capacity.
5. To facilitate the uptake of the technology and measurement infrastructure developed in the project by the European Metrology Network on Smart Electricity Grids and the measurement supply chain (grid operators, electricity network and equipment manufacturers and operators of RES generation plants), standards developing organisations (CENELEC TC8X and IEC TC 8) and end users (offshore windfarm, European Network of Transmission System Operators (ENTSO-E)).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

In particular, proposers should outline the achievements of the EMPIR project 15NRM05 ROCOF and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.2 M€, and has defined an upper limit of 2.7 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

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 generation and distribution, and electronic instrumentation sectors.

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 the potential European Partnership on Metrology 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.