

## Title: Measurement tools for Smart Grid stability and quality

### Abstract

Smart Grids are primarily required to dynamically balance variable renewable supply with variable demand to achieve grid stability and prevent a degradation of power quality (PQ), that would otherwise lead to cascading failures and power blackouts.

Network operators and planners need tools to measure the quality and stability of the electricity supply under dynamic conditions.

Wide area measurements using phasor measurement units (PMU) at remote locations are key to the monitoring of grid stability and PQ propagation. There is also a requirement to develop new tools based on PMUs to determine accurate and actionable network information to manage Smart Grids.

### Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 10, 23, and 31.

### Keywords

Smart Grids, Power Quality, Phasor Measurement Units (PMU), Wide-Area Measurement Systems (WAMS), Synchrophasor, Renewables, Electricity Distribution, Electricity Transmission.

### Background to the Metrological Challenges

Unlike traditional electricity generation, power provided by renewable energy sources is inherently non-predictable nor controllable leading to power quality and system stability difficulties. Network PQ and stability is also dependent on the connected loads, impedance and network topology which lead to a need for measurements to determine the network parameters and dynamic response. There is a critical need for Europe’s metrology infrastructure to engage with new/amended normative standards and grid codes and provide the necessary measurement infrastructure to deal with future grid power supplies and loads.

The EMRP project ENG04 SmartGrid has provided the infrastructure for on-site PQ measurements and has demonstrated measurements at a number of industrial sites. However, methods to understand (measure and analyse) how these PQ events change over the wider network due to attenuation or resonance are not well developed.

Network impedance measurements have been addressed by some researchers and there is some initial work being carried out in ENG 07 HVDC. However, this work is rudimentary and more reliable, practical and safe methods are required

Hence there is an essential need for metrology grade non-invasive sensors with errors comparable to the other components in the measurement

### Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on the traceable measurement and characterisation of power quality and stability in Smart Grids.

The specific objectives are to:

1. To perform measurements of power quality (PQ) at geographically dispersed locations in a Smart Grid to analyse the propagation of power quality disturbances throughout the network to determine the most significant sources of disturbing influences on the network; and to develop and demonstrate on-site measurement system methods for the measurement of network impedance in HV/MV/LV networks and associated resonance points.
2. To develop and validate new PMU algorithms that are suitable for LV and MV distribution networks. These networks are characterised by smaller distance, lower phase shift and hence require higher phase sensitivity whilst accounting for a higher level of PQ disturbances. Also to develop new measurement and calibration methods for the dynamic performance of PMUs as proposed in IEEE standard C37-118.1 (2011). To undertake on-site calibration of installed PMUs to verify operation and accuracy in realistic conditions.
3. To develop metrology-grade grid transducers and grid diagnostic tools including non-invasive transducers and algorithms for on-site measurement of emerging PQ parameters as defined by standardisation and industrial need. Reconcile the propagation of transducer uncertainties through complex PQ and PMU algorithms. Develop laboratory test equipment for calibration of the non-invasive transducers or commercial non-conventional transformer test equipment as defined by standardisation and industrial need. Also to develop wide area techniques for grid fault location and network diagnostics.
4. To provide metrology input and pre-normative research to the evolution of International (CENELEC, IEC) standards concerning PMUs for network controllability and PQ in a Smart Grid context.

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 R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

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 EMRP projects ENG04 SmartGrid, and ENG07 HVDC and how their proposal will build on these.

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. The available budget for integral Research Excellence Grants is 30 months of effort.

## Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the sector comprising the Network operators and manufacturers of Power Quality measurement and analysis tools.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

**Time-scale**

The project should be of up to 3 years duration.