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

Selected Research Topic number: **SRT-n04**
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: Metrology support for enhanced energy efficiency in DC railway systems

Abstract

Direct Current (DC) railway systems, supplied by unidirectional substations, show significant energy-saving potential due to their inability to fully recover the energy produced by electric braking. To improve their energy efficiency, the adoption of non-conventional substations (bidirectional and/or with storage systems) is needed, along with standardised procedures for the determination of real energetic performances of DC railway installations and guidelines for the efficient management of the entire system. This proposal will address the standardisation need identified by CEN/CLC TC 9X and IEC TC9, and develop methodologies that combine accurate measurements and circuit models of the railway electric system.

Keywords

Power/energy measurement, energy efficiency, DC railway supply system, bidirectional substations, energy storage systems, energy losses, harmonic pollution, AC/DC converter.

Background to the Metrological Challenges

To support the delivery of the European Green Deal objectives in the transport field, the European Commission has proposed 2021 to be the European Year of Rail. As one of the most sustainable and safest modes of transport, rail will play a major role in Europe's future mobility system. Rail is considered to be environmentally friendly and also energy efficient. The topic of the energy efficiency in the railway system is of increasing relevance. Technical specifications from railway companies relating to procurement of new trains or by the infrastructure managers for the new supply systems were in the past mainly related to the reliability and resilience of the systems, completely neglecting energy efficiency. Nowadays, specifications on energy efficiency are routinely added. To support the research on specifications for non-conventional DC substations and their performance assessment, CEN/CLC TC 9X and IEC TC9 have identified unaddressed needs for defining rules for the efficient management of the DC supply system and methodologies for the analysis of the performances of the non-conventional DC substations.

In the railway systems supplied by unidirectional DC substations, the energy regenerated by the traction units must be consumed within the DC grids. The extra-energy generated by electric braking is dissipated by braking rheostat and thus wasted. An energy analysis performed on experimental data recorded during the monitoring of different railway traction-units in a commercial service showed that a value ranging from few percent up to 50 % of the traction energy is dissipated, amounting to several hundreds of kilowatt-hours for a single journey. The recovery of such an amount of energy considerably reduces the CO_2 emission of the electric transport and improves the quality of the air inside the metro tunnel due to the reduction of microscopic particles from braking pads and the overheating produced by the braking rheostats. The evolution of power electronics has introduced new approaches to the design of DC railway substations (non-conventional substation) that promise substantial increase of energy recovery. For example, different configurations of supply systems that allow the flow of excess power from DC to AC (reversible substations) or/and that adopts stationary storage systems, even at high voltage, have been proposed and are currently installed. However, standardised methodologies for the assessment of the performance of these new installations that safeguard both the designer, the supplier, the installer and the railway infrastructure manager do not exist.

The technical report CLC/TR 50646 that defines specifications for reversible DC substations tackles unaddressed standardisation needs for the effective characterisation of these installations. In particular, the report lists a series of key performance indexes that should be proved by the substation provider that are at the moment not yet standardised: (i) energy saving (comparison with the ante-opera energy consumption), (ii) performance in terms of harmonic compensation on AC and DC side, (iii) performance in terms of reactive power compensation, (iv) determination of efficiency at different levels of the converter group and for different operation modes (traction, regeneration).

There is also a standardisation need for the development of measurement methodologies and uncertainty evaluations in support of efficient new storage installations, concerning the storage systems (batteries, self-capacitors) that can be integrated in the non-conventional substation, and measurement procedures for validation of the effects in terms of energy saving. One of the parameters that quantify the impact of the installation of a non-conventional substation is the line receptivity, defined as the capability of the system to recover the electric braking energy produced by rolling stock. Nevertheless, there is no standard definition of such parameter nor standard methodology to measure it. Therefore, a methodology that allows to simulate the

entire railway system accounting for the different architectures of the non-conventional substations that combines a circuit model with electric measurements collected in-field and the knowledge of the control algorithm for the management of the energy flows would be an essential support in both the design phase and the post-opera energy analysis.

IEC TC9 WG50 is currently developing a new family of five standards addressing electronic power converters for fixed installations. However, not much consideration is given to losses of the power converters; on-site tests of losses estimation and the overall efficiency estimation are not being dealt with at all. Standardised methodologies and procedures for the on-site accurate determination of power-conversion and storage systems losses will simplify the assessment of compliance with technical specification of tenders. Moreover, they will provide a clear and unambiguous way to define the efficiency constraints in the technical specification of a tender that can be accepted by both the supplier and the customer.

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 enhanced energy efficiency in DC railway systems.

The specific objectives are

1. To provide an overview on possible configurations for the non-conventional DC substations (e.g. bidirectional and/or with storage systems) including evaluation of pros and cons for each configuration. To perform a survey on real installations focusing on the design characteristics and the expected or declared energy savings.
2. To develop, calibrate and apply on-site setups and algorithms for the measurement of the energy losses of the unidirectional and bi-directional substations (converters step-up and step-down transformers) and the charge-discharge efficiency of electric storage device (converter and storage system) with an overall uncertainty better than 2 %. This should include the determination of the harmonic pollution on both the AC and DC side up to 20 kHz and the analysis of the transient events produced by the functioning of the bi-directional substation.
3. To develop and characterise a methodology for the estimation of the effects of new non-conventional substation installations in terms of energy saving and improved line receptivity. To validate the methodology by combining on-site measurements and a model describing the whole railway system, and to apply the methodology to test cases. In addition, to propose measurement procedures for the energy efficiency impact of non-conventional substations as well as a definition of line receptivity.
4. To collaborate with the European and International Standards Developing Organisations (such as IEC TC9 WG50) and the users of the standards they develop, to ensure that the outputs of the project are aligned with their needs, including the provision of a report on methodology for the on-site assessment of compliance of new installations with the tender requirements and recommendations for incorporation of this information into future 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 EMPIR project 16ENG04 MyRailS 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 railway transportation 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 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.

Additional information

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

https://msu.euramet.org/current_calls/pre_norm_2021/documents/cen_priority_001.pdf