



Publishable Summary for 18NET03 SEG-net Support for a European Metrology Network on smart electricity grids

Overview

Electricity grids are a key enabler of the “**Energy Transition**” towards a sustainable energy system, but face huge challenges due to, for example, the desired uptake of renewable energy sources and electric vehicles. So far, over 20 joint research projects (JRPs) funded by EURAMET’s European metrology research programmes have provided crucial metrology support for the development of (smart) electricity grids, but their impact has been hampered by a lack of higher-level coordination. This project accelerated the full establishment of a European Metrology Network on Smart Electricity Grids (EMN SEG) to realize a coherent National Metrology Institute (NMI) response to smart electricity grid measurement challenges, to provide a single point of contact for stakeholders, and to maximize the impact of R&D activities.

Need

The European Commission’s Energy Union strategy to “build a low-carbon, climate resilient future” via “secure, clean and efficient energy”, has a profound impact on electricity grids – the backbone of our modern society. Grid stability and quality of supply is negatively affected by the significant uptake of renewable energy sources (RES) and grid energy losses need to be reduced in order to meet EU climate targets. Over 20 joint research projects under the iMERA-Plus, EMRP and EMPIR programs have so far provided crucial metrology and normative support to the development of smart electricity grids, with extensive stakeholder interaction and support. However, there was a significant need for more coordination in electricity grid metrology focusing on stakeholders’ technological and strategic objectives.

Stakeholders needed long-term commitment and a coherent, well-considered joint R&D agenda to ensure that all their metrology needs are adequately addressed, and that measurement solutions are available when they need them. The metrology community recognised that it could only meet these challenges by agreeing, well in advance with all relevant stakeholders, what metrology is needed and when, and by carefully coordinating national programs within the framework of a European joint Strategic Research Agenda (SRA). Once R&D results were available, the stakeholders needed easy access to these results. They did not want to navigate a plethora of individual project websites but instead needed a simple, comprehensive platform that provides all information and answers across the full range of their needs. Next to easy access to R&D results, there was a need for practical knowledge transfer. Whilst utility engineers, manufacturers, and companies lacked the particular metrological knowledge required to fully implement the smart electricity grid, there was no systematic program satisfying the full metrology training needs of this stakeholder community.

The stakeholder needs in smart electricity grid metrology are extensive and call for major investments in an adequate European metrology infrastructure. Given these investments, a complete and comprehensive European metrology infrastructure can only be sustained by smart specialisation, where each country focusses its activities and investments based on its (unique) expertise and the national stakeholder needs. At the same time the complete range of NMI capabilities in Europe will optimally cover the needs of all EU stakeholders.

For measurement issues related to the energy transition and smart electricity grids, European stakeholder organisations wanted to move away from the present ad-hoc and project-based contacts with individual NMIs, to a more systematic contact with a recognizable entity that represents the metrology community. On the NMI side, there was an increased need to become more visible as utilities and industry were all too often unaware of the significant added value that metrology research can provide. EURAMET decided to initiate a European Metrology Network on Smart Electricity Grids to optimize the use of limited NMI resources in meeting smart electricity grid industry and standardisation challenges. Given the urgency to achieve this aim, there was a need to support and accelerate the full implementation of the EMN.



Objectives

The overall aim of this project was to support the European Metrology Network on Smart Electricity Grids and to accelerate its full implementation via the achievement of the following objectives:

1. To establish systems within the EMN to coordinate and align national R&D strategies, including:
 - Developing a European joint strategic research agenda together with all relevant stakeholders, describing current and future stakeholder metrology needs related to smart electricity grids.
 - Defining roadmaps and strategies to meet these needs. To discuss prioritisation of national R&D strategies with the aim of preventing unnecessary duplication and optimizing the use of precious resources.
 - Liaising with instrument manufacturers and other relevant stakeholders to ensure that early take-up of future metrology R&D is incorporated into the defined strategies.
2. To significantly enhance exploitation and uptake of research results from multiple EMRP and EMPIR joint research projects and national research activities through the realisation of a virtual knowledge hub, which will serve as a single point of contact to stakeholders, providing easy access to the full range of smart electricity grid metrology research results, relevant NMI calibration services, and a help desk to submit metrology needs and/or request further information.
3. To develop a plan for a joint sustainable European metrology infrastructure for Smart Electricity Grids by stimulating smart specialisation of European NMI facilities and services, including:
 - Producing a comprehensive overview of existing facilities and services across Europe and identifying deficiencies.
 - Promoting alignment of national R&D priorities with these deficiencies and with the future needs of stakeholders.
 - Stimulating sharing and use of existing large grid-metrology infrastructure by all participants in the network and by the wider stakeholder community.
4. To create a widely visible identity as the voice of the European electricity grid metrology community (including logo, flyers, newsletters, etc) and to establish liaisons with relevant European stakeholder organisations such as ENTSO-E, CENELEC, WELMEC, EURELECTRIC, TD Europe, ESMIG and similar organisations worldwide such as IEC, OIML, CIGRÉ, with the European JRC on Smart Electricity Systems and Interoperability, and with related European H2020 research projects.
5. To set up an extensive knowledge transfer program for the associated EMN consisting of training courses, webinars, best practice guides, and other materials such as publications, events and R&D activities with a significant training component, and a web-based platform to attract and stimulate exchange of metrology R&D researchers.

Results

Strategic research agenda for smart electricity grid metrology and technical implementation roadmap (Objective 1)

At the start of the SEG-net project, a first version of the Strategic Research Agenda (SRA) was drafted based on the extensive stakeholder information that the EMN SEG member and partners had acquired over the past decade. The SRA includes a short introduction on EURAMET and the EMN concept, an overview of Smart Electrical Grids in the framework of the European Green Deal, several generic grid challenges and a description of the related measurement infrastructure. The main chapter of the SRA covers the measurement challenges in electricity grids, divided over 9 themes: revenue metering, power quality, digital substations, instrument transformers and sensors, grid monitoring and data analytics, efficiency, high-voltage testing, DC grids and applications, and grid integration.

The draft SRA was later shared with the EMN SEG stakeholder community, together with an extensive survey inviting comments. In total, 80 stakeholders from 15 countries and several pan-European organisations participated in the survey. Further stakeholder feedback was sought on the SRA via personal contacts with key stakeholders, and three online workshops. The findings of the three consultation tracks were consolidated



to enhance the measurement challenge list corresponding to each of the 9 themes. In the final version of the SRA, each theme has an implementation roadmap displaying all measurement challenges categorized over an implementation timeline. The intention is that future revisions of the SRA by the EMN will profit from the lessons learned from the entire process.

The SRA with the collection of the stakeholder needs has already been very successful in steering new project proposals of the EMN SEG community as part of the EMPIR 2019 Energy Call, the EMPIR 2020 Normative Call, the 2021 Green Deal and Normative calls of the European Partnership on Metrology (the Partnership), and more recently the 2022 Integrated European Metrology and Normative Partnership calls. High-quality Proposed Research Topics (PRTs) based on the SRA were produced and were selected as Selected Research Topics (SRTs) with a success rate of about 80 %. At present, five EMPIR 2019 projects (19ENG08 WindEFCY, 19ENG02 FutureEnergy, 19NRM05 IT4Q, 19NRM07 HV-com2, 19RPT01 QuantumPower), an EMPIR 2020 project (20NRM03 DC Grids), and a Partnership 2021 project (21NRM02 Digital-IT) are developing their R&D activities and two further Partnership 2022 projects (22NRM04 e-TRENY, 22NRM06 ADMIT) have started in the summer of 2023.

In setting up these Joint Research Projects, NMIs and DIs brought in their specific expertise that lined up with their national strengths and priorities (see “Smart Specialisation” below), in order to achieve optimal use of national resources in meeting the stakeholders’ measurement challenges. Furthermore, the liaisons started by the EMN were found very helpful in assuring the proposed JRPs were aligning with stakeholders’ needs and in receiving support letters for the JRP proposals.

EMN virtual knowledge hub (Objective 2)

As a starting point for the design of the EMN’s virtual knowledge hub, an extensive functional specification was developed together with “wireframe” prototypes of the webpages. In this development, smart grid experts worked closely with a professional web developer in multiple iterations to achieve the desired results. The specification was then verified with coordinators of previous and running smart grid metrology projects, and with stakeholders from key stakeholder groups. In the following stage, the functional specification and the wireframes were implemented by EURAMET’s web contractor as a first implementation on the live platform. The final website went live in June 2022 with an extensive set of contents including, notably, all the R&D results obtained by the EMN SEG community in projects funded by iMERA+, EMRP and EMPIR over the last 15 years as well as the R&D being performed in on-going projects.

A handbook was written on the development and maintenance of the virtual knowledge hub, including technical instructions and guidance on how to maintain a consistent presentation of the contents over the years ahead, including after the conclusion of this project, thus enabling sustainability of the knowledge hub.

Smart specialisation (Objective 3)

The project performed an extensive survey under the European NMIs and designated institutes (DIs) active in the area of smart electricity grids with the aim to produce an overview of the existing metrology landscape for electrical energy covering current measurement capabilities, national priorities, and existing infrastructure. Based on the results of this enquiry, an overview report was prepared and an analysis was made of the gaps and overlaps in order to optimize the limited national resources in tackling stakeholder challenges. Following this analysis, a strategy has been developed within the EMN SEG to achieve an adequate and sustainable metrology infrastructure through smart specialization. This strategy will ensure that, as far as possible, the needs of all stakeholders are met, with countries still having the final decision on where to become active and where to focus their activities.

EMN identity and liaisons (Objective 4)

A strong EMN identity is essential for its recognition, visibility and influence with stakeholders, research funders, regulators and governments. It is also crucial for establishing international leadership through a single recognizable entity that represents the metrology community in discussions on measurement issues related to the energy transition and smart electricity grids. The project collaborated closely with EURAMET in the production of specific material to promote the EMN and to present the EMN at stakeholder events in a form that follows the EURAMET style guide for EMNs. A logo was developed for the EMN, as well as for the nine main themes in the EMN. In addition, templates for presentations, posters, newsletters, etc were produced.



To enhance the interaction of the smart electricity grid metrology community with strategic stakeholders, the project produced an overview of the wider (smart) electricity grid community in Europe and subsequently established liaisons on behalf of EMN SEG with at least 5 high-level EU stakeholder organisations. The overview covers the complete range of stakeholder communities: utilities, industry associations, manufacturers, standard organisations, and universities.

An “EMN SEG strategic liaison plan” was developed and extensive contacts were maintained with CEN-CENELEC TC38 “Instrument Transformers”, CEN-CENELEC TC14 “Power Transformers” and IEC TC42 “High voltage and high current technology”. In parallel, contacts were established with certain key stakeholders (European Commission Smart Grids Task Force, CEN CENELEC ETSI CG, ESMIG, RSE, EDF, TERNAL).

To further strengthen the links with stakeholders, a series of news bulletins in strong collaboration with EURAMET were published. The first issue of the newsletter was published in March 2022, the second in September 2022, the third issue in March 2023 and the fourth issue in July 2023.

Knowledge Transfer program (Objective 5)

To improve the dissemination of the knowledge resulting from the smart electricity grid metrology joint research projects, all EMN SEG members and partners provided information on their present and planned training and other knowledge transfer activities. The resulting overview showed that the majority of training courses from the EMN members concerned the basics of metrology and measurement uncertainty, highlighting the opportunity for (joint) development of training courses focused on EMN-specific topics.

Furthermore, an excellence course on “Measurement and metrology for smart electricity grids” was organised jointly with INRIM and Politecnico di Torino. The course aimed at providing an extensive overview of the general measurement challenges related to smart electricity grids together with in-depth training on related selected key metrology challenges, having PhD students and young NMI/DI researchers as a main target attendance. The course was included in the high level courses (Excellence training) of the 2021-2022 PhD programme in Metrology of the Doctorate School of Politecnico di Torino and was successfully held in May 2022 with the participation of about 80 people overall.

Information about the training programme will be made accessible via a dissemination and training section of the virtual knowledge hub expected to go live in the autumn of 2023. In addition, a web-based platform is presently being set up on the virtual knowledge hub to promote guest researcher opportunities, MSc / PhD positions, and student internships.

As a joint knowledge transfer action, a EURAMET EMN joint booth on Energy and Environment was organised by the EMN SEG at the CIM 2023 partner exhibition Global Industrie in March 2023.

Impact

The project partners presented EMN SEG at 13 International and European conferences, including EURAMET events. Additionally, 14 presentations were made to key IEC and CEN-CENELEC technical committees. A significant highlight was the joint EMN SEG - EMN Energy Gases (EG) promotion of metrology research in support of the energy transition during a stakeholder event at the European Parliament held on 4 February 2020. This event was part of the “11th European Innovation Summit” organized by the Knowledge for Innovation (K4I) platform, to advocate the role of metrology in achieving the EU Green Deal aims. With two Members of Parliament hosting the event, and more than 60 attendees, the fully-booked event was highly successful in promoting the relevance of the EMN SEG and EMN EG in realizing the EU Green Deal objectives. In a follow-up event on 5 May 2021, organized by IPQ and the Portuguese Government, again the role of measurement science (as promoted by the EMN SEG, EG and COO) in delivering the EU’s Green Deal was presented.

For stakeholders, this project and its associated EMN has greatly reduced the previous ad hoc approach to meeting their smart electricity grid metrology needs. Increased specialisation of NMIs stimulated by the project will enable more efficient use of resources, thus allowing stakeholders’ needs to be covered more effectively. Aligning and focusing R&D activities via the strategies for implementing the joint SRA developed in the project will increase the scientific output and stimulate scientific cooperation between NMIs and with universities and other research institutes. Most of all, it will ensure that the needs of all stakeholders will be met more consistently. Impact studies have proven that such consistent metrology support enhances the competitiveness of companies and that it results in more jobs.



Furthermore, the realisation of the virtual knowledge hub has significantly contributed to increased exploitation and uptake of electrical grid metrology R&D. Allowing stakeholders to access R&D results by topic rather than by project alone has greatly increased the accessibility of the project's results. The concise knowledge transfer program developed in this project and implemented within EMN SEG has further enhanced the dissemination of the acquired metrology knowledge to the stakeholder community. In terms of long-lasting impact, the project's outputs will lay the foundations for the realisation of a 'natural metrology partner' for stakeholder organisations, as a single voice of the European smart electricity grid metrology community, which will greatly enhance the formal interaction with stakeholder organisations. The impact of this cannot be overestimated, as one of the major deficiencies encountered by all NMIs active in the area was the low visibility of metrology and the lack of awareness of what metrology can contribute to solving stakeholders' business challenges.

The SRA and smart specialisation strategy developed by the project will allow NMIs to use their scarce resources in a more effective and complementary way, and this will lead to a more structured approach in national R&D programs. Easy access to large and expensive facilities in other countries will enlarge the service portfolio that NMIs can offer to national customers. As such, the increased visibility realized by the project and its associated EMN via a recognizable identity and high-level liaisons will be a major asset to NMIs for increasing general awareness and recognition of the metrology contribution to the realisation of smart electricity grids. More involvement in solving stakeholder problems will not only generate new income, but also prove the impact and added value of metrology to society.

Moreover, the enhanced visibility and the dedicated training program developed by the project aims to attract students, young researchers and electrical engineers to the area of smart electricity grid metrology, increasing their skills and providing them with a specific and deep metrology background. This will help alleviate a significant problem that is encountered by NMIs i.e. in hiring staff that are both interested and adequately trained in smart electricity grid metrology. In the course of this project, several requests for student opportunities within the EMN have already been received. Moreover, there was a significant interest in the "Excellence Course" on Smart Grid Metrology, held in May 2022, with more than 80 students attending.

The SRA, including the prioritisation and implementation plan, as realized by the project will be crucial to ensure that the challenges with the largest economic impacts will be covered by future metrology research. The cooperation and smart specialisation stimulated by the EMN will help to ensure that the metrology efforts will lead to a larger portfolio of facilities in Europe, covering a wider range of stakeholder needs than without EMN coordination. This increased and more effective metrology support to stakeholders will further improve the already strong competitive position of European manufacturers. Indeed, early impact was already achieved in the first three project years: as already mentioned above, based on the early drafts of the SRA, 17 new project proposals have been submitted in the EMPIR 2019 Energy Call, the EMPIR 2020 Normative Call, and more recently in the 2021 Green Deal, 2022 Integrated European Metrology and 2021 – 2022 Normative Calls of the European Partnership on Metrology, to cover the most urgent needs identified in the SRA. The exceptional success of the PRTs in these calls indicates the high degree of impact the EMN has had on recognizing the most relevant topics in the field of Smart Grid through the development of the SRA.

The CEN-CENELEC market perspective and innovation director already testified that metrology makes an important contribution to standardisation for smart electricity grids. This has been confirmed by several national standardisation committees and by the strong standardisation component in the over 20 smart electricity grid-related JRPs, 7 of which are fully dedicated to standardisation support. The regular interaction between CENELEC and the smart electricity grid metrology community, realized via this project and its associated EMN, has helped to identify standardisation R&D needs at an earlier stage and resulted in better coverage of these needs by research projects. In this way, the project and its associated EMN have given an impetus to the development of pan-European documentary standards and grid codes that are vital to ensure that equipment from different smart electricity grid vendors can be used inter-changeably and that common grid limits and constraints are applied, based on reliable measurements. This added value is recognized by key technical committees of IEC and CEN-CENELEC and has led to strong contacts with CEN-CENELEC TC38 "Instrument Transformers", CEN-CENELEC TC14 "Power Transformers" and IEC TC42 "High voltage and high current technology".

The most significant social impact of the associated EMN lies in its contribution to a more reliable and more efficient electricity grid as the key enabler of the "Energy Transition": the electricity grid is essential for reliable integration of sufficient renewable energy sources to meet the EU 2050 target of 50 % renewable energy supplies. Improved metrology support to a stable and high-quality electricity supply, based on sustainable



energy sources such as wind and solar, is at the heart of the EMN on Smart Electricity Grids. This project and its associated EMN are improving the coordination and organisation beyond individual research projects, thus reducing the risk of key metrology not being ready when needed and avoiding potentially delaying the successful implementation of EU energy policies. The coherent, pan-European approach to smart electricity grid metrology, as realized by this project, will thus have a profound impact on society. Finally, this project and the EMN will ensure reduced emissions of carbon dioxide and greenhouse gases in two ways: firstly, via support to the increased uptake of renewable energy sources (RES) to the EU energy mix, and secondly, via support to the implementation of more efficient electricity grids. In this wider sense, this project and the EMN for Smart Electricity Grids will thus help to address the requirements of the Paris agreement by tackling climate change.

Project start date and duration:		1 May 2019, 48 months
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Internal Funded Partners:	External Funded Partners:	Unfunded Partners:
1. VSL, Netherlands		5. METAS, Switzerland
2. INRIM, Italy		6. PTB, Germany
3. LNE, France		
4. NPL, UK		