



Expert group report

Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR)

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Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR)

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EUROPEAN COMMISSION

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Evaluation of the European Metrology Programme
for Innovation and Research (EMPIR)***

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EXECUTIVE SUMMARY

The EMRP programme

The international measurement system was established in 1875, with the Metre Convention and since then measurement has been recognised *as a science in itself*. Measurement has played a critical role in science ever since and was an integral part of the framework programmes until FP6 when MERA was formed for the metrology community. Following on from this the pilot call (iMERA-plus) was launched in 2007, worth EUR 64.6 million with the European Commission providing EUR 21 million. This allowed the funding of 21 collaborative projects.

The success of iMERA paved the way for the European Metrology Research Programme (EMRP) as a fully-fledged public-public partnership under the treaty on the Functioning of the European Union. The co-funding system allowed the Participating States to commit EUR 200 million, with an equal amount provided by the European Commission, creating a programme worth EUR 400 million. Its aim is to support the objectives of the European National Measurement Systems and the core activity consists of multi-partner transnational projects, carried out by National Metrology Institutes (NMIs) and their Designated Institutes (DIs). The coordination of activities through an implementation structure, constituted by EURAMET, has been central in reaching these objectives.

The first call was in 2009 and the final call in 2013, with the last projects ending in 2017. As the programme is in its final stages and EMPIR, the successor programme, have started the Expert Group were able to review all the documents and interview individuals who have been involved in the programme. Questionnaires to key stakeholders, including EURAMET Technical Committees and national ministries, and results from a EC public consultation with 250 replies were analysed by the group. In addition, the group made use of the external mid-term evaluation carried out by an independent expert group in 2011. These sources of information formed the basis for the evaluation.

In the overall assessment of the EMRP, the experts consider that it provided a significant contribution to the historical initial goal of contributing to the development of a European Infrastructure for metrology, with 119 collaborative research projects. It was less successful in respect to the other two main goals, supporting the national measurement systems, and contributing to the grand challenges. The experts identify the main reason for this less satisfactory result was because the overall structure was too closed to the NMIs. This consideration is in full agreement with the intermediate evaluation report, where it was stated that *“the scale of the EMRP seemed sufficient to create a genuine core ERA in metrology but it would have to become inclusive of the wider research community to be the platform for a true European Research Area in metrology”*.

The EU added value for the programme was considered good, with a solid long-term commitment from the Participating States, leveraging a total of EUR 219.2 million of national funding. EURAMET ran the programme efficiently, e.g. proposal evaluation was on average kept below two months throughout the call years. The programme was coherent with FP7 and the programme was relevant to the measurement community. Regarding integration, the programme did increase the research activities of smaller NMIs, and it managed to involve most of European NMIs into the programme.

Overall, the EMRP programme was considered a successful programme, meeting its objectives and specific goals but leaving room for improvement with respect to the two main goals.

The EMPIR Programme

Based on the success of EMRP and on the priorities of Horizon 2020, the “European Metrology Programme for Innovation and Research” (EMPIR), was launched as its successor, part funded by Horizon 2020 (EUR 300 million) and part funded by the Participating States (EUR 300 million). The first call was in 2014 and the final call will be in 2020. It has two main goals:

- To support European National Measurement Systems, with the vision of a shared infrastructure throughout Europe, and
- To contribute to economic and societal grand challenges facing the EU.

The goal of contributing to economic and societal needs and challenges is also a defined aim, whilst in the EMRP it was considered as an additional benefit. This change of perspective is in line with the

underlying shift in the general policy: in FP7 the “structuring” aspect was apparent, whilst in Horizon 2020 the focus was on providing answers to critical problems. This change of perspective is an important point for our evaluation.

To assess the progress the Expert Group considered in detail the 2015 Annual Report issued by EURAMET, the consultation and the Intermediate Report of the Expert Group for EMRP, plus the consultation documents issued in 2016. In addition, interviews of people involved in EMPIR were undertaken, as well as questionnaires and the public consultation described above and their inputs helped to formulate opinions.

From the EMRP mid-term review the following statement was considered important when considering the successor programme: “The overall opinion of the expert panel was that EMRP is a well-managed joint European research programme that has already achieved a relatively high level of scientific, management and financial integration. However, the expert panel noted its limited industrial exploitation, limited opening to excellent science outside the metrology institutes and insufficient capacity building”.

As a result of these remarks, a major structural change was introduced to EMPIR, namely the possibility of research groups other than NMIs and their designated institutes to participate in Joint Projects as funded partners. This was in keeping with the policies of Horizon 2020 and this Expert Group is in full agreement that this was an effective decision for EMPIR. External participants are now currently participating in the projects. The level of participation is reaching the target of the programme, where the external participants are receiving on average 30% of the EU funding.

At the end of this mid-term review the Expert Group believes that EMPIR has made good progress towards meeting the majority of objectives for the programme, with administrative costs of EUR 1.7 million, and very promising links with increasing European turnover through uptake of the developed technologies.

The experts consider that EMPIR will achieve greater impacts than EMRP, thanks to the broader scope of the programme and its greater openness. They believe that the impact of EMPIR can be further strengthened and that improvements in this direction are necessary to pave the way for a successor programme.

Recommendations for the EMPIR programme

The following recommendations are made:

- 1) Increase the coherence and links with scientific research and policies at large:
 - a) EURAMET should involve external industrial, academic and research partners in the programming process when selecting call topics. Future calls should focus increasingly on areas where research is needed to support implementation of emerging policy needs, e.g. European legislation such as the Water Framework Directive, and the Directive concerning medical devices.
 - b) In order to broaden and increase the involvement and research capabilities of the NMIs the responsible ministries should take necessary steps to provide the NMIs with the flexibility to fully use the resources provided by EMPIR for the execution of their activities.
 - c) The European Commission services should ensure the coordination and coherence between the EMPIR activities and the relevant Horizon 2020 calls, including those supporting public-public or public-private partnerships.
- 2) To improve the impact from existing and future projects:
 - a) For all future funded projects the impact evaluation must have a long-term component, which could form part of the evaluation criteria. In addition, in the research for SI units the requirements for uncertainty should be supported by a clear driver from industry or society.
 - b) EURAMET should take the necessary steps to increase the accessibility of impact information on its web page, and it should be centralised with a specific access page for impact.
- 3) Support for further leverage capabilities
 - a) There should be an increase in Horizon 2020 programmes that NMIs are involved in. A goal could be set where 10% of funded projects that NMIs are involved in are funded through Horizon 2020. This may replace the goal of achieving 10% funding from the structural funds.
 - b) To establish a more integrated measurement society within Europe, EURAMET should set up a task force including external experts to further define the concept and advance the establishment of an EU integrated measurement society, including its global cooperation.

To sum up, the experts consider EMPIR successful, especially thanks to its greater openness compared to EMRP, and believe that further improvement in this direction is possible and necessary for a successor programme.

Considerations and recommendations for a successor programme

The experts strongly believe that there should be a follow up programme dedicated to measurement, as an independent discipline. Such a programme would greatly contribute to the general policy objectives of the European Union. This is also in line with the opinions expressed by the large majority at the stakeholder and public consultations.

The main conclusion from EMRP and EMPIR has been that they did not include the wider measurement community sufficiently. The successor programme needs to address this with a more inclusive programme for measurement and encourage the Member States and their NMIs and the Commission Services to enter in to an open dialogue with all stakeholders, including academia, researchers and industry. This should be reflected not only in an adequate increase in budget, but also by adequate structures and activities beyond funding of projects in order to improve outreach and communication, in particular towards policy makers¹.

A future European programme needs to be fully coherent with European and national policies. Participation should remain open to all those eligible for the Framework Programme. Currently full

¹ This recommendation must be seen in the light of the strong increasing budgets for measurement in countries like China and India [IA 2013] and the USA which doubled the budget for their NMI over the last 10 years [<http://www.sciencemag.org/news/2012/02/nist-14-budget-increase-would-measure-nicely>, <https://www.nist.gov/about-nist/our-organization/budget-planning>].

participation is limited to national metrology agencies. Accordingly, the opportunity must be taken with the successor programme, whether under Article 185 or another instrument that supports joint funding with Member States, to open up the programme to the wider measurement community.

The experts are proposing a number of high level recommendations that a successor programme should take into account in order to establish a more comprehensive European Measurement society in full support of European competitiveness.

- 1) Strategic challenges in metrology and measurement
 - a) The NMIs, together with EURAMET and other stakeholders, should ensure that a future programme contributes to a balanced and economically viable system in Europe for all SI units.
 - b) Centres of excellence for research in applications of measurement should be considered.

- 2) Stakeholder participation
 - a) Industrial and academic groups involved in measurement should play a more significant role in the research projects.
 - b) The "Knowledge triangle: research, innovation and education" should be considered as an innovative vision for the National Measurement System (NMS), creating collaboration between academia, industry and society.
 - c) Governance should include all the actors and stakeholders involved in measurement. Specifically, this should include NMIs, academia, research institutes, industry and relevant agencies at the national and European level.

- 3) Programme implementation should include:
 - a) The development of measurement science, including measurement-modelling issues, as required.
 - b) The contribution of measurement to economic, environmental and societal challenges.
 - c) Dedicated activities addressing measurement technologies beyond the state of the art to ensure European leadership in emerging areas.

1. INTRODUCTION

1.1 BACKGROUND

Measurement and metrology: historical background

Measurement, as both an investigation tool and a decision support, has been present all through mankind's history. Measurement has a dual nature: it provides an invaluable direct support to key human activities and it constitutes a science in itself. This dual nature is an important fact, which has consequences in the current state of art. In both aspects, two main advancements took place in the nineteenth century, namely:

- The establishment of the international system of metrology, with the Metre Convention (1875), which created the *Bureau International des Poids et Mesures* (BIPM), the intergovernmental organisation through which Member States act together on matters related to measurement science and measurement standards. This was the result of a unification and standardisation process that started with the Enlightenment culture [Sartori *posthumous* 2014], and;
- The recognition of measurement *as a science in itself*, with the first key studies on measurement theory, including key contributions by Gauss (theory of errors [Gauss 1809]), Maxwell (theory of measurement units [Maxwell 1873]), and Helmholtz (first seminal ideas of the representational theory [Helmholtz 1887]).

The twentieth century also witnesses noteworthy progress. The scope of the Metre Convention was revised and extended and additional fundamental quantities were progressively included. The name, International System of Units, with the abbreviation SI, was given to the system in 1960. In 1971 the current version of the SI was completed by adding the mole as the base unit for amount of substance, bringing the total number of base units to seven.

In the last part of the twentieth century the functionality of the system was reinforced and made more effective by the institution of a Mutual Recognition Arrangement (CIPM MRA, 1999), which specifies the organisational and technical requirements for the mutual recognition of measurements performed by National Metrology Institutes (NMIs).

On the methodological side, the need of accompanying measurement results with a statement on their uncertainty was recognised as a means of providing complete measurement information. This led to the publication of the "Guide for expression of uncertainty in measurement" (GUM), in 1993 [JCGM 100]. Similarly, the revision of the language in metrology was carried out, which yielded the publication of the "International vocabulary of basic and general terms in metrology" (1984), now at its third edition [JGCM 2012].

Measurement and metrology today

What are then the current status and trends of measurement?

Concerning research, there is a reference structure, which is the International Measurement Confederation (IMEKO, www.imeko.org), which covers, through its 22 Technical Committees, virtually all the aspects of measurement. IMEKO organises a general World Congress, every three years, and annual Congresses related to the TCs, in between two successive World Congresses. Another important organisation is the IEEE Instrumentation and Measurement Society, which organises annually a Congress (I2MTC), attended by measurement and instrumentation researchers and professionals throughout the world, while Joint Research Centre of the European Commission, EuCheMS and Eurachem have activities in measurements in the field of (bio)chemistry.

There are also a few top level journals, totally devoted to measurement (Measurement, Metrologia, Measurement Science and Technology, IEEE Transaction on Instrumentation and Measurement) and others strongly related to it (Accreditation and Quality Assurance).

In industry, the case of sensors is emblematic: they are key components in most industrial activities and constitute a big business themselves [AMA 2016]. For example, the German Association for Sensors and Measurement (AMA) estimates the current German sensor industry to 250.000 employees and to a revenue of EUR 35 billion. They also say that we will have around 100 sensors per habitant of the earth [AMA 2017]. This sector obviously receives contributions for the whole world of measurement; spinoffs are often created in this area. Another important aspect is

the emerging role of complex *measurement systems*, in the factory, in laboratories, in hospitals, on board vehicles and in environment monitoring systems. They are real measurement networks, often complying with specific protocols, as the fieldbus, in its many variations. The capacity of designing, managing and updating such a system is a specific measurement related competence today.

Lastly, let us mention some general trends in metrology/measurement [Wal 2009]. They include:

- The development in the demands of classical metrology (improved clocks for navigation, smaller dimensions, higher and lower temperatures) as well as a detailed reconfiguration of the International System of Units (SI)
- Measurement in key areas, where the need for reliable quantitative data is increasing:
 - Distributed, highly interconnected measuring systems (in production [Imkamp 2016], in critical areas...)
 - Environment and the atmosphere
 - Food science (including trace elements)
 - Nano-science
 - Scientific measurements in medicine
- A new concept of measurement: *measuring directly the interaction of physical phenomena with persons*,
 - Through the physiological response (physiological measurements), or
 - Through the perceptual response (soft metrology [Pointer, 2003]).

Measurement and the EC Research Programmes

The European Commission has recognised the scientific, economic and social importance of measurement.

In 1973, the BCR (*Bureau Communautaire de Référence*) programme was established, in order to assist in the establishment of reliable and comparable measurement systems in the European Union (EU) Member States.

In the Second Framework Programme for Research and Technological Development, measurement was present “to ensure that, with the achievement of the internal market by the end of 1992, the analysis and measurement laboratories of all Member States will have the technical means necessary to guarantee the uniform application of standards, technical regulations and directives” [FP2-BCR 4, 1988-1992].

In the third Framework Programme, a dedicated Measurement and Testing programme appeared, with the aim of contributing to “the harmonisation and improvement of methods of measurement and analysis when these methods are not sufficiently precise and laboratories obtain differing results”. The scope was widened to address the new goals, such as the “monitoring of environment and health”, and “the resolution of the new challenges faced by industry” [FP3 (1992-94)].

This paved the way to the further extension, with “Standards, Measurements and Testing (SMT)” as a specific programme within the Fourth Framework Programme. It aimed “to improve the competitiveness of European industry, to support the implementation of other Community policies and to meet the needs of society” [FP4 (1994-98)].

The Fifth Framework Programme included four thematic programmes, in one of which, “Competitive and sustainable growth”, the generic activity “Measurements and testing”, was included. Here measurement was still included, although *the scope was reduced* to the, though important, support to growth [FP5 (1998-2002)].

In the next FP6 (2002-06) there was not a specific programme for measurement as a whole. The view prevailing at that time was that “measurement and testing will be *integrated* in all activities, in particular in the thematic priorities and policy orientated research” [Raldow 2002].

However, a project was funded, "Metrology for the European Research Area" (MERA, 2002-3), to study the possibility of a closer cooperation between the NMIs in Europe. This was followed by the coordination activity carried out through the iMERA, an ERA-NET Coordination Action (2005-07) that prepared the scenario for FP7.

Also, it is important to note that the "Measuring the Impossible" Programme was a part of the NEST (New and Emerging Science and Technology) Programme under FP6. The programme was very successful and the Expert Group recommends probing this really innovative subject further as inspiration for future programming.

Alongside FP7 (2007-13), the European Metrology Research Programme (EMRP, 2009-13) ran, as a part of the specific programme "Cooperation" [Law EMRP 2009]. An ERA-NET plus programme, iMERA-plus, paved the way for the launch through a pilot call, with EUR 21 million of EU funding. EMRP took advantage of the funding opportunity related to Article 169 TEC, now Article 185 TFEU², with the aim of supporting the objectives of the European National Measurement Systems (NMSs). The NMS can be defined as "the collective infrastructure of national facilities, expertise, knowledge, research and legal framework for reliable, consistent and internationally recognised measurement" [NMO 2011]. This is a wide vision, tending to include all the organisations directly and primarily involved in measurement, although, in this perspective, it is somewhat surprising the absence of Academia. This may be perhaps explained by the "technical" circumstance that the NMS depends upon the Ministry of Industry, whilst Universities are typically under the Ministry of Education and Research. In other countries, a narrower vision has been adopted and the National *Measurement System* has been rather interpreted as a National *Metrology System*, basically constituted by NMIs and DIs. The conception of the NMS is an important strategic issue, and will be discussed further at a later stage in this Report.

The objectives of the EMRP were "to accelerate the development, validation and exploitation of new measuring techniques, standards, processes, instruments, reference materials and knowledge aimed at driving innovative developments in industry and commerce, improving the quality of data for science, industry and policymaking and supporting the development and implementation of directives and regulations". The core activity of EMRP consisted of multi-partner transnational projects, carried out by NMIs and DIs. EMRP took advantage of an implementation structure, constituted by the European Association of National Metrologic Institutes (EURAMET), constituted in 2007, as an evolution of the European Organisation of Metrology (EUROMET), constituted in 1987, as a regional (European) coordination body for NMIs. EUR 200 million of EU funding was made available, with a core commitment of EUR 200 million from the Participating states. A reserve commitment from the Participating states was also made available to ensure an efficient implementation.

With the latest framework programme, Horizon 2020 (2014-2020) [Horizon 2020], the experience of EMRP gave rise to the "European Metrology Programme for Innovation and Research" (EMPIR, 2014-2024) [Law EMPIR 2014]. EMPIR aims at:

(a) providing appropriate, integrated and fit-for-purpose metrology solutions supporting innovation and industrial competitiveness, as well as measurement technologies addressing societal challenges such as health, environment and energy, including support to policy development and implementation;

(b) creating an integrated European Metrology Research system with critical mass and active engagement at regional, national, European and international level.

One of the main differences between the EMRP and EMPIR is the involvement of non-NMIs and non-DIs as directly funded partners.

This has been, in short, the history of the relationship between measurement and European research.

² Article 185 (formerly Art. 169 of TEC) is a part of Title XIX, Research and technological development and space, of the Treaty on the functioning of the European Union, and states that: "In implementing the multiannual framework programme, the Union may make provision, in agreement with the Member States concerned, for participation in research and development programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes"

1.2 TERMS OF REFERENCE

The Terms of Reference for the Expert group have been published on the Commission transparency register³. The expert panel worked in accordance with these terms and the report meets the scope of the evaluation that the expert group is required to fulfill.

Working approach and methodology

The work was carried out by four independent experts with complementary expertise, under the leadership of Giovanni Rossi as the Chairperson and Diana Hodgins as the Rapporteur.

A number of relevant documents for both EMRP and EMPIR plus those written by EURAMET on the topics have been read and, where relevant, referenced in the text.

The people invited to a face to face interview in Brussels and one phone interview were:

| | |
|----------------------|--|
| Paula Knee | EURAMET Impact Officer |
| Erkki Ikonen | EMRP/EMPIR Committee Chair |
| Maguelonne Chambon | EURAMET Member of BoD |
| Maria Luisa Rastello | EURAMET Vice Chair (GA) |
| Graham Machin | EURAMET TC Chair Thermometry, Project Coordinator, IND01 HITEM |
| Beat Jeckelmann | EURAMET Chairman |
| Zijad Džemić | EURAMET Member of BoD |
| Joern Stenger | Former EMRP/EMPIR Chair, EURAMET Member of BoD |
| Andrew Lewis | Project Coordinator, IND53 LUMINAR |
| Pavel Klenovsky | EURAMET Member of BoD |
| Duncan Jarvis | EMRP/EMPIR Programme Manager |
| Martin Milton | Director BIPM (Phone interview) |

A questionnaire was prepared for each group and sent at least a week prior to the interview to allow the individual to prepare. All interviews were conducted with all experts present plus two members from the European Commission. The questionnaire for the EURAMET Board is provided in the Appendix.

In addition, a questionnaire was sent by the Commission to relevant contacts in the ministries, all TC Chairs and to a list of project participants. The replies from those who responded were collated and provided to the expert panel.

The experts held four two-day meetings in Brussels, two of which included time for the face to face interviews. The meetings were also used to discuss the input from the interviews and reports and share opinions before drafting the report. The deadline for the final report was June 2017. The public consultation summary [Public Consult 2016], with 250 replies, was also referenced in the evaluation.

³ <http://ec.europa.eu/transparency/regexpert/>, Group code: E03462

2. EMRP

2.1 OVERVIEW OF EMRP

Aims and objectives

The objectives of the EMRP were to accelerate the development, validation and exploitation of new measuring techniques, processes and instruments. In addition, the goal was to increase knowledge and build upon and introduce new measurement standards where necessary. This would serve to drive innovative products and services in industry and commerce, addressing a wide variety of societal challenges such as energy, health and energy [Int Report EMRP 2012].

The EMRP aimed to support metrology research in any technological or industrial field by providing the legal and organisational framework required to support large scale European co-operation between Member States and funding projects that could tackle the significant new technological and scientific challenges facing the metrology community.

The core of the EMRP was (i) funding trans-national EMRP projects which addressed research, technological development, (ii) training and (iii) dissemination activities. Only National Metrology Institutes and Designated Institutes could be funded for their work, but other partners were able to participate at their own expense. In addition, researcher grant schemes were funded to diversify capabilities and complement the EMRP projects.

The programme was designed around themes focused on the FP7 grand societal challenges (energy, environment, health, industry) as well as supporting important developments in the international systems of units (the SI).

Structure and activities

In accordance with the agreement between the Member States and the European Community under FP7, a dedicated implementation structure had to be formulated that would take responsibility for the implementation of the EMRP programme. The European Association of National Metrology Institutes, 'EURAMET' was registered as a legal entity in Germany to undertake these activities governed by the NMIs.

EURAMET is responsible for the launch for calls for proposals, evaluation of the proposals, awarding the funding to chosen proposals, ensuring the projects are run in accordance with the guidelines and the handling of the funding from the community to these projects when they achieve their goals.

Funding and financial integration

At the outset participating Member States [EMRP Final Rep 2016] agreed to make a financial contribution of a minimum of EUR 200 million plus a reserve funding of a further EUR 100 million. Any other member state or any country associated with the Seventh Framework Programme was entitled to join the EMRP at a later stage.

The Community financial contribution would match that of the Member States, but was subject to commitments of resources from the Member States and payment of their financial contributions. It was also dependent upon a dedicated implementation structure which was the responsibility of the Member States to establish and execute the EMRP. This structure was the recipient of the Community financial contribution and was formed to ensure efficient execution of the EMRP.

It was a requirement that the Commission conduct an interim and final evaluation to assess the quality and efficiency of the EMRP.

EURAMET is entirely responsible for the implementation of the EMRP programme.

2.2 EMRP: OBJECTIVES AND ACHIEVEMENTS AGAINST OBJECTIVES

Objectives with corresponding indicators

EMRP objectives are defined in

- Decision 912/2009 [Law EMRP 2009]
- Annex of the General Agreement [General Agreement Annex EMRP 2009]
- EURAMET document Input to the EMRP Ex Post Evaluation [EMRP Input Ex-Post 2016]

EMRP Objectives [Law EMRP 2009] [General Agreement Annex EMRP 2009].

The EMRP will integrate the national programmes of 22 participating States into a single joint research programme and support, in particular, the objectives of the European National Measurement Systems.

The objectives of the EMRP are:

- (i) to accelerate the development, validation and exploitation of new measuring techniques, standards, processes, instruments, reference materials and knowledge aimed at driving innovative developments in industry and commerce,
- (ii) to improve the quality of data for science, industry and policymaking and
- (iii) to support the development and implementation of directives and regulations.

The EURAMET document [EMRP Input Ex-Post 2016] specifies:

- Over-arching objective
- Specific objectives (focus on programme level achievements and impact)
- Operational objectives (focus on programme delivery and activities)

| EMRP Over-arching objective [EMRP Input Ex-Post 2016] | | | | | |
|---|--|---|---------|---|-------------------------------|
| In order to contribute to achieving the general European policy objectives, it will be necessary to improve the efficiency and effectiveness of public metrology research programming in Europe in areas where it is facing major societal challenges | | | | | |
| SPECIFIC OBJECTIVES | | INDICATORS | | | |
| S1.1 | Structuring the ERA through coordinating and partly integrating national public metrology research programmes to provide solutions to important European societal challenges. | Leveraging investments and co-funding of EMRP by the participating States | I1S1.1 | National funding committed and effectively spent on EMRP: the target is EUR 200 million spent by the participating States; identification of the use of the reserve funding capability. | |
| S1.2 | Improve the efficiency of Europe's fragmented public metrology research approach | Programme efficiency | I2S1.2 | Time required between the closure of the call for EMRP proposals or for researcher grants and the date where information on the outcome of the evaluation is sent to the applicants. | <i>Efficiency</i> |
| S1.3 | To remove barriers between national metrology research programmes and to foster sustainable cross-border cooperation e.g. through mobility of young researchers, scientists and academic staff and to open up the national programmes to inter-disciplinary cooperation with researchers and scientists from other fields in particular relating to new and emerging technologies. | Progress towards the integration of national programmes | I3S1.3 | Common definition of research topics following the EMRP and involving third parties through the call for potential research topics. | <i>Scientific integration</i> |
| | | | I3bS1.3 | Effectively working central evaluation with independent experts, and central selection decision. | |
| | | | I3cS1.3 | The dedicated implementation structure is in place and is effectively implementing EMRP. | <i>Management integration</i> |
| | | | I3dS1.3 | The use of a common contract (model grant agreement per category of activity) linking all the fund recipients to EURAMET. | |
| | | | I3eS1.3 | The projects selected at central level are effectively co-funded by the participating States from their national earmarked budget and the reserve funding capability, according to the order in the ranking list. | <i>Financial integration</i> |
| I3fS1.3 | The Community contribution is allocated to the projects according to the order of the ranking list. | | | | |

| | | | | | |
|------|--|--------------------|---------|---|--|
| | | | I3gS1.3 | Progress towards more financial integration through the use of harmonised financial rules (e.g. eligibility of costs, funding rates, ex-post verification). | |
| S1.4 | To increase the impact of these programmes, both S&T impacts (scientific excellence, pooling of resources, data and expertise, achievement of critical mass, facilitating programme optimisation) and economic and societal impacts. | No indicators set. | | | |

The requested document could not be displayed.

Specific objectives with corresponding indicators and assessment

S1.1 Structuring the ERA through coordinating and partly integrating national public metrology research programmes to provide solutions to important European societal challenges

I1S1.1 National funding committed and effectively spent on EMRP: The target is EUR 200 million spent by participating States; identification of the use of the reserve funding capability.

The programme exceeded its target of EUR 200 million funding committed and expended from national sources. A total of EUR 219.236 million from national sources was allocated to EMRP activities. National commitments were largely in line with the original plan, with variations due to the uncertainties inherent in a competitive project selection process.

The structure has helped ensure that 50% of the dedicated NMI budgets were coordinated within the EMRP, but the degree of coordination was lower for those countries that have a less centralised metrology research structure or in cases where the NMI do not have a strong scientific metrology function.

S1.2 Improve the efficiency of Europe's fragmented public metrology research approach

I2S1.2 The time required between the closure of the call for EMRP proposals or for researchers grants and the date where information on the outcome of the evaluation is sent to the applicants

The average time during 2010-2013 was 55 days, but this indicator is not the most appropriate to evaluate the objective. More important is that the national metrology research systems were extremely diverse and the EMRP imposed a structured management process on all participants and, as a result many NMIs have learned how to work efficiently with more professional management systems.

S1.3 To remove barriers between national metrology research programmes and to foster sustainable cross-border cooperation e.g. through mobility of young researchers, scientists and academic staff and to open up the national programmes to inter-disciplinary cooperation with researchers and scientists from other fields in particular relating to new and emerging technologies

I3aS1.3 Common definition of research topics following the EMRP and involving third parties through the call for potential research topics

At the national level, metrology programme owners supported the common definition of research topics at the European level by relinquishing control over a large proportion of their national programmes (EUR 219 million - which is a significant proportion of national funding for metrology research) and allowing the research topics to be defined via the processes of EMRP.

The greatest integration of the national metrology programmes comes through the construction of the Selected Research Topics (SRT) and the proposals in response to those. Over the life of the programme nearly half the total metrology research in the EMRP Member States is funded through the Programme.

Third parties, including industrialists and academics, were involved in the initial phase of proposing potential research topics through events.

I3bS1.3 Effectively working central evaluation with independent experts and central selection decision

Independent Observer at the Review Conference for the last EMRP call in 2013 stated: "One of the most impressive features of the EMRP is the culture of continuous improvement. Further refinements had clearly been implemented for the 2013 Call, including some that were derived from consideration of 2012 recommendations." The expert group agrees that the evaluation phase is working efficiently.

I3cS1.3 The dedicated implementation structure is in place and is effectively implementing EMRP

The Commission reiterated mid-term EMRP evaluation in a press release on the Programme that stated "EMRP is a well-managed and progressively more and more integrated European programme. It has transformed a specialised and fragmented community into a successful public-public partnership confirming the advantages of the European Research Area." The expert group agrees that EURAMET is effectively implementing EMRP, and is taking into account the framework set up under Article 185 TFEU.

I3dS1.3 The use of a common contract (model grant agreement per category of activity) linking all the fund recipients to EURAMET

The same model contract is used for all joint research projects. Similarly there is a standard model contract for each type of Researcher Grant.

I3eS1.3 The projects selected at central level are affectively co-funded by the participating States from their national earmarked budget and the reserve funding capability, according to the order of the ranking list

I3fS1.3 The community contribution is allocated to the projects according to the order of the ranking list

The proposed joint research projects are scored and ranked (against the standard FP7 criteria) by independent experts at a Review Conference. Projects are then formally selected for funding by the EMRP Committee according to the order in the ranked lists.

The selected projects are co-funded by the Commission allocation to EMRP and the national programmes' commitment to EMRP.

I3gS1.3 Progress towards more financial integration through the use of harmonised financial rules (e.g. eligibility of costs, funding rates, ex post verification)

The programme manages EU funding and coordinates national metrology research funds using a common approach to financial rules.

From the start the programme adopted a model contract and financial process based on FP7 rules. EURAMET published its own Financial Guidelines tailored to the contract and removed options in the FP7 generic documents that were not relevant to this programme. Guidelines and templates were provided to support project partners to cost projects at the outset and to ensure finances were reported consistently and in accordance with the financial rules.

The Full Economic Cost (FEC) model required under FP7 was implemented in EMRP. As project costing methods and financial management processes varied greatly among the NMI/DI institutions, the move to the FEC approach was a significant change for many NMIs/DIs.

S1.4 To Increase the impact of these programmes, both S&T impacts (scientific excellence, pooling of resources, data and expertise, achievement of critical mass, facilitating programme optimisation) and economic and societal impacts

Scientific impact

Economic impact

Social impact

This part is discussed in Section 2.7.

Operational objectives with corresponding indicators and assessment

O1.1 Cross-border public research programme coordination and integration

I1O1.1 Number of Member States involved in EMRP and National Programmes actively coordinated

23 national metrology research programmes were actively coordinated via EMRP. Each country has formally made a commitment to participate in EMRP as specified in the EMRP Decision (No 912/2009/EC) of the European Parliament and Council. These 23 countries are the EMRP 'participating states' and are 19 EU Member States plus four non-EU countries and the EU Joint Research Centre (JRC).

In addition to the participating states, organisations from five other EU Member States and 16 non-EU countries have formally participated in EMRP projects as unfunded partners in JRPs and/or funded partners via EMRP researcher grants.

In the mid-term report it was noted that EMRP helped reduce the gap in expertise between NMIs but mobility aspect across borders remains problematic. Furthermore, for the grand challenges NMIs were encouraged to work by technology theme and there was a limited possibility to involve additional researchers in EMRP projects.

O1.2 Address the grand challenges (e.g. climate change) and areas with pressing metrology needs

I2O1.2 Number of research projects which build on the specific strength of NMI and DI and their infrastructure and their impact on primary standards

All 119 EMRP projects were designed to build on the specific strengths of NMIs and DIs. The projects supported improved and developed this expertise to ensure that the European measurement infrastructure provides traceability to primary standards in areas important to the European economy and society. Projects addressed both the accuracy of the underpinning SI units and measurement research to address the grand challenges.

The Programme deliberately chose cross-disciplinary themes, addressing the grand challenges and using the emerging technologies, which cut across the traditional disciplines. The topics addressed are interdisciplinary and multidisciplinary (environment, health, energy and general industry requirements), and cooperation is taking place among scientists of different countries and regions. Most of the projects were in the area of physical measurements. The expert group notes that chemical measurements do also have a huge role in addressing Grand Challenges, and could have been further addressed.

It was recommended at the mid-term review that the selection process for Strategic Research Topics for each Call could be more supportive of an opening and go beyond the requirement "that relevant expertise and facilities exist within EURAMET to address those needs". The partners could also explore the potential added value of organising stakeholder workshops to prioritise Strategic Research Topics, especially for Grand Challenge Calls where a more open minded culture would be desirable.

O1.3 Enable some "new" Member States or candidate countries to build metrology research capacity

I3aO1.3 Number of New Member States building up metrology capacities

I3bO1.3 Increase in metrology capacity of Member States and countries associated with FP7 whose metrology programmes are at an early stage of development

Seven of the EMRP participating states are new Member States. These seven countries have participated in joint research projects funded under EMRP enabling them to collaborate in metrology research projects with more experienced Member States to develop their metrology capabilities. Three additional new Member States have also participated in EMRP projects via Researcher Grants.

Participation in EMRP processes and projects enabled countries in new Member States and accession /pre- accession states with developing NMIs and DIs to increase and improve their metrology capacities and their research skills. Six capacity building case studies are provided in the EURAMET report [EMRP Input Ex-Post 2016].

The EMRP created aspirations to build national research capacity amongst the smaller NMIs and those in the newer Member States. However, these aspirations were frustrated by a lack of research personnel and insufficient national budget for JRPs. The former made it very difficult to exploit the mobility grants and the latter meant their involvement in research projects was marginal. Seven of the 22 countries had an in-kind budget of less than EUR 1 million to co-fund JRPs in 11 thematic call areas. This encouraged some of the smaller countries to be quite strategic and prioritise specific niche areas for participation. This is considered positive, where such niche areas can also serve as a seed for centres of excellence [N. Poposki, 2009].

Whilst the joint research programme was fully open to all NMIs and DIs the reality was that

- some participating countries did not have either the resources (mostly financial) or the expertise to participate effectively. The positive effect was it forced them to specialise.
- In some cases, the participating budgets were two orders of magnitude below that of the largest countries, which, even when calculating per capita is not matched across EU countries.

O1.4 Open access to unique research infrastructures and facilities:

I4O1.4 Number of research infrastructures jointly used in RTD projects

The measurement infrastructure in each country includes also a research infrastructure – the NMIs and DIs in each country provide both specialist facilities and expertise to conduct measurement research and when relevant also deliver measurement services to measurement users. Therefore, each participation by a NMI or DI in a joint research project constitutes a sharing of research infrastructures. This amounts to 957 research infrastructures jointly used across the 119 EMRP projects.

In addition, the researcher mobility grants supported a very direct method of sharing of research infrastructures by enabling the movement of researchers between the national research infrastructures.

O1.5 Increase generic collaboration between national metrology research programmes with the relevant science community at European level

I5aO1.5 Number of research organisations (not being NMI or DI) involved in EMRP projects

I5bO1.5 Level of participation in the programme by outside researchers and research institutions

I5cO1.5 Total PhDs trained in metrology

In addition to participation from NMI and DIs, there were 1147 participations in EMRP projects from 916 organisations.

50% (570) of participations were from universities and public research organisations and 41% (474) from industry.

They participated as:

- Unfunded project partners - i.e. full project partners providing a defined contribution to the projects.
- Grant recipients - providing additional funded contributions to projects
- Collaborators - signing an NDA with the projects to enable them to contribute to the project and network with project partners

25 PhDs in metrology have been published.

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| O1.6 Modernisation in the programming of national and European research priorities |
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| I6O1.6 List of advanced technologies employed in the developments of primary standards can and should be transferred to new and challenging research activities |
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Metrology research makes use of advanced technologies to develop next generation techniques for realising primary measurement standards. In the process it develops primary measurement standards, advanced technologies, tools and techniques that may be applied to challenging research activities. Examples from EMRP projects include graphene, single photon technologies, single electron technologies, atomic and optical clocks, large volume metrology, advanced spectroscopic techniques.

The overt EMRP focus on grand challenges and new technologies appears to be supporting an evolutionary modernisation trend within the NMIs in terms of cross-disciplinary research but there is some "cultural resistance" from traditional metrology disciplines. Some of the smaller NMIs are making strategic decisions and selecting areas for specialisation, which is considered a good approach. It helps to develop more balanced expertise across Europe.

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| O1.7 Foster mobility of "early-stage" researchers from NMIs and DIs |
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| I7O1.7 Number of mobility grants implemented |
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73 mobility grants were implemented, 30% of which were for early stage. These enabled researchers to spend time at other institutions.

Whilst there were two EMRP instruments to support mobility of researchers at the mid-term review staff-related and bureaucratic barriers were limiting their use of these. The traditional, academic approach to mobility where the individual is relocated to an institute in another country was considered too inflexible for the metrology community.

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| O1.8 Europe should speak with one voice at global level |
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| I8O1.8 Number of generic cooperation activities with non-European research actors |
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There has been significant participation from non-European research actors in the programme. There were 140 participations in EMRP projects by non-European research actors from the NMI/DI, academic and industrial communities either as unfunded partners or collaborators.

The EMRP projects addressing the research for the forthcoming redefinition of the SI, have played an important focal point for international activity, bringing together the European expertise and international NMIs via the unfunded partner and collaborator mechanisms.

There are some indications that both EURAMET e.V. and the EMRP are increasing the profile of Europe as a 'leader' in the application of metrology to societal and technological challenges. This may, in due course, enable Europe to speak with a single voice but this is not the case at present as there is not yet a single strategic plan for European centres of excellence in metrology.

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| O1.9 Metrology research: a supporting activity for government regulation and standardisation |
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| I9aO1.9 Number of EMRP projects with direct references to regulation |
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| I9bO1.9 Number of presentations at standardisation technical committees or working groups |
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The EMRP Energy, Environment and Health themes have a strong focus on regulation with many projects addressing regulatory issues. A number of projects in other themes (such as Industry and SI Broader scope) also address regulation. In total 42 projects (out of the 119 funded) have direct reference to regulation. They are listed in [EMRP Input Ex-Post 2016].

At the end of 2015, 739 contributions had been made to 379 unique standards committees. To date this has resulted in contributions to 17 published and 103 draft standards.

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| O1.10 Support to industry and economic growth |
| I10aO1.10 Number of scientific publications |
| I10bO1.10 Number of presentations at congresses |
| I10cO1.10 Number of patents granted |
| I10dO1.10 Dissemination activities/Number and quality of activities related to metrology communication and diffusion |
| I10eO1.10 Number and quality of training activities |

1358 papers have been published to date. In addition 581 peer-reviewed papers were published in conference proceedings and 32 contributions made to books.

3928 contributions have been made at conferences - 2728 presentations and 1200 posters

36 patent applications have been made to date. None have yet been granted. It should be noted that not all projects have finished yet and therefore more patent applications may arise.

1556 activities have been undertaken to communicate and diffuse the outputs of EMRP projects. In the majority of cases (89%) the target audiences were measurement users in the industrial, public sector and academic communities. The remainder (11%) were targeted at the general public.

676 training activities have been undertaken. Of these:

- 302 were focused on training for the NMI/DI community
- 374 were focused in training of users of metrology Conclusions

Conclusions

The final report on EMRP [EMRP Final Rep 2016] provides good evidence that there was considerable progress against the majority of specific and operational objectives. The Expert Group therefore agree that the project can be closed with a successful conclusion.

However, the Expert Group consider that it is necessary to comment on two topics, since these are addressed and considered in the follow up programme. These topics were also raised at the mid-term EMRP review.

- The operational objective to have a number of research projects which build on the specific strength of NMIs and DIs may not be a good indicator as it does not allow for the broadening of scope for measurement projects.
- The involvement of smaller NMIs was limited. One reason for this may have been that funds had to be committed when they first joined and therefore there was no scope to increase their commitment. It could also be that they were unable to develop the smaller NMIs, who had limited research capabilities at the start.

In addition, despite having clear overall objectives, these were not addressed in detail. From the interviews, it was considered that the progress towards these objectives was less convincing. Since these objectives are similar in the follow up EMPIR programme, recommendations have been made under that programme.

2.3 EFFICIENCY OF EMRP

Implementation

As noted in the EURAMET Report [EMRP Final Rep 2016], the implementation of EMRP was largely delegated to EURAMET, which “implemented a dedicated and centralised governance and management processes for the programme from the outset, made up of the EMRP Committee, an EMRP Programme Manager and a dedicated Management and Support Unit (MSU). The delivery of the programme has been monitored and reviewed in various ways (annual reports, audits, Interim Evaluation, etc.)”. In the same report it is also pointed out that “no significant problems or issues have arisen” and that “the Interim Evaluation found the programme processes to be high quality and transparent and in line with the Commission’s requirements”.

Overall, the choice of entrusting EURAMET to the implementation of EMRP, have led to a generally efficient management.

The implementation process, described in the above quoted report, proceeded according the following main steps.

- The programme was guided by a common research agenda developed by the European metrology community under the precursor programme iMERA+.
- Call scopes were developed by the EMRP Committee.
- A two-stage call process brought the European metrology community together, along with the academic community and measurement research end-users, to develop and deliver collaborative research projects.
- This two-stage process reduced the effort spent on proposals that would have been unsuccessful.
- Project selection was based on an assessment, by the EMRP committee, of alignment with strategic requirements (stage 1) and independent expert review (stage 2). The Interim Evaluation of EMRP and the annual independent observers’ reports confirm that this process was independent.

All participating countries could and, in most cases, did participate in all levels of programme and project design and governance.

Guidelines and templates were provided to support project partners who were new to this approach, helping them to cost projects and ensure finances were reported consistently and in accordance with the financial rules.

A relevant indicator for the implementation process is “The time required between the closure of the call for EMRP proposals or for researcher grants and the date where information on the outcome of the evaluation is sent to the applicants”. Between the 2010 and 2013 calls the average time was 55 days. For Researcher Grants, the time between call close and the communication of results to the applicant was planned to be one month, and this was met in the majority of cases, but as the individual consortia were responsible for the final selection there were times that this took longer.

The greatest integration of the national metrology programmes came through the construction of the Selected Research Topics (SRT) and the proposals in response to those.

Over the life of the programme nearly half the total metrology research in the EMRP Member States was funded through the Programme. Governance

Governance

EURAMET implemented dedicated and centralised governance and management processes for the programme from the outset, made up of the EMRP Committee, an EMRP Programme Manager and a dedicated Management and Support Unit (MSU).

The Commission reiterated in a press release on the Programme that “EMRP is a well-managed and progressively more and more integrated European programme. It has transformed a specialised and fragmented community into a successful public-public partnership confirming the advantages of the European Research Area.” The Expert Group agree with this opinion.

Supervision

The delivery of the programme has been monitored and reviewed in various ways (annual reports, audits, Interim Evaluation, etc.) and no significant problems or issues have arisen. The Interim Evaluation found the programme processes to be high quality and transparent and in line with the Commission's requirements.

The EMRP Committee were responsible for interaction with interested parties outside the NMIs and from this suggest topics for the calls.

Conclusions

Overall, the Expert Group believe that EURAMET has managed the EMRP programme efficiently.

2.4 RELEVANCE AND APPROPRIATNESS OF EMRP

EMRP was established to help strengthen the metrology community in Europe. The overall objective was to improve the efficiency and effectiveness of public metrology research programming in Europe in areas where it was facing major societal challenges.

The EMRP programme provided a framework for the national NMIs and DIs to work together on fundamental metrology topics such as the development of enhanced SI measurements, as well as metrology projects for industry, which addressed both aspects. At the end of this programme the stakeholders, namely the European Commission and the national governments responsible for metrology considered EMRP had achieved its goals.

Interviews were conducted with Directors of NMIs, EURAMET Board Members and project managers. It is fair to say that from all of these interviews there was 100 percent support of the programme. The reasons for this differed slightly between the individuals, but there were some themes that were common to all:

- The programme provided additional funding for their research and this was seen as positive.
- There was greater sharing of expertise between NMIs, primarily within projects.
- They had more involvement with industry.

In addition in the majority of cases the individual projects clearly addressed societal challenges and provided input to relevant directives and regulations.

There was general agreement from the interviews that each country wished to retain its own independence regarding its metrology services and were happy to carry out research across borders. The consensus was that:

- national metrology services are independent from research programmes. Calibration and legal metrology services are in the private sector, which is not limited by country borders. Private companies apply for permission for legal metrology service through the NMI in a country where they want to provide services, and NMI must grant permission once all criteria are fulfilled.
- research expertise was not going to be consolidated or topics specified for different countries.

These findings demonstrate that EMRP was relevant to the broader European Research Agenda (ERA) and the FP7 research and development programme. It was also considered appropriate for the NMI community across the EU.

However, it should be noted that a fully 'Integrated European Metrology Research system with critical mass was not completely achieved during EMRP and may not be an appropriate goal. If the countries are not prepared to jointly agree on how research and topics are shared, the programme goals are not appropriate to the national structures. As this theme also applies to EMPIR the Expert Group have made recommendations of how it may be addressed under that programme.

In summary it can be considered that the aims of EMRP were appropriate and relevant but were not fully achievable within the structure set out in the programme.

2.5 COHERENCE WITH OTHER INITIATIVES WHICH ARE THEMATICALLY RELATED

The coherence of EMRP with other EU policy instruments

There is a number of different EU funding schemes where aspects of the objectives and the societal challenges were aligned to those of EMRP and therefore should be considered when assessing the coherence of EMRP with other EU policy instruments. As EMRP was an Art 185 programme it received 50% of its funding from the FP7 programme.

FP7

FP7 was the European Union's Research and Innovation funding Programme for 2007-2013 [FP7] with EUR 50.6 billion of funding made available, of which EUR 32.4 billion was spent to address the Grand Challenges and specific technologies: Health; Food, Agriculture, and Biotechnology; Information and Communication Technologies; Nanosciences, Nanotechnologies, Materials and new Production Technologies; Energy; Environment (including Climate Change); Transport (including Aeronautics); Socio-economic Sciences and Humanities; Space; Security; and General Activities.

The Co-ordination and Support Action (CSA) within FP7 addressed 'Accompanying Measures' such as **standardisation**, dissemination, awareness-raising and communication, networking, coordination or support services, policy dialogues and mutual learning exercises and studies.

European Institute of Innovation and Technology

The European Institute of Innovation and Technology (EIT) was founded in 2008 and complementary to the goals of FP7. It was an independent EU body set up to enhance the EU's ability to innovate by nurturing entrepreneurial talent and supporting new ideas. The EIT set up a number of Knowledge and Innovation Communities (KICs) around Europe, with each one focusing on a specific societal challenge:

Current: Climate, Digital, InnoEnergy, Health, Raw materials, Food

Planned: Added-value manufacturing and urban mobility

European Joint Programme Cofund

European Joint Programme (EJP) Cofund was a co-fund action available under FP7, designed to support coordinated national research and innovation programmes. The EJP Cofund aimed at attracting and pooling a critical mass of national resources on objectives and challenges of FP7 and at achieving significant economies of scales by adding related FP7 resources to a joint effort. It addressed the same societal challenges as FP7.

For completeness, the EMRP societal challenges were:

Health, Energy, Environment, Industry. In addition, *Fundamental Metrology* and Standardisation were included in the calls. Only Fundamental Metrology was not included in FP7 or the associated programmes.

Analysis and conclusions

The EMRP grand challenges were aligned with FP7, EIT and EJP, all of which had a strong research focus where measurement would play a key part and the wider measurement community were able to participate. EURAMET should have had more documented discussions with these other funding bodies in order to ensure there was coherence with their projects, minimal overlap of the topics and the breadth of expertise was sufficient from the NMIs and DIs for the chosen EMRP projects. For wider topics, they should have encouraged partners to explore these complementary programmes. The result was that some EMRP projects did not include sufficient expertise from the wider measurement community and these topics would have been better addressed under one of the other programmes.

There was also no evidence of dissemination from EMRP exclusively to FP7 stakeholders, further highlighting the lack of communications between the programmes.

These concerns were also raised in the EMRP mid-term report and not fully addressed. As the follow on EMPIR programme was similarly structured the recommendations on how these concerns could be addressed have been covered under that programme.

2.6 EFFECTIVENESS AND CONTRIBUTION TO THE GENERAL POLICY OBJECTIVES

Background: Policy objectives under the EMRP Programme

The scope of European research progressively moved from the initial economist approach to a broader vision that included the free circulation of persons and ideas. This was expressed as the European Research Area (ERA): a unified research area open to the world and based on the internal market, in which researchers, scientific knowledge and technology can *circulate freely* and through which the Union and its Member States strengthen their scientific and technological bases, their *competitiveness* and their capacity to collectively address *grand challenges*" [EU Explain 2016]. This perspective was firstly defined in 2000 in the communication "Towards a European Research Area" [Toward ERA], and further refined, in 2002, in the communication "The ERA: Providing new momentum" [ERA]. Three key statements merit highlighting: *free circulation of researchers, competitiveness, and grand challenges*.

In that environment, FP7 took place, starting in 2007. It included some specific programmes that can themselves be identified as objectives that, to some extent, even go beyond the research realm, and raise general political issues. They are:

- *Cooperation*, fostering collaboration between industry and academia to gain leadership in key technology areas.
- *Ideas*, supporting basic research at the scientific frontiers
- *People*, supporting mobility and career development for researchers both within and outside Europe.
- *Capacities*, helping develop the capacities that Europe needs to be a thriving knowledge-based economy.
- *Nuclear research*, developing Europe's nuclear fission and fusion capabilities.

This was basically the scenario under which EMRP took place.

Assessment of the EMRP Programme in respect to general policy objectives

The EMRP resulted from the vision of a European Infrastructure for Metrology that was firstly presented in a Conference, held in Warsaw, in 2002. Commissioner Busquin noted that "Measurement, testing and the definition of common standards, are essential elements in the establishment of a knowledge-based economy that the European Union is striving to build" [Busquin, 2002]. Therefore, he concluded that "in this context, a powerful European metrology infrastructure is crucial to ensure the proper functioning of the European single market and to strengthen the competitive position of European enterprises in the global marketplace." It appears that this vision is in full agreement with the ERA vision and that it may validly contribute to it. That idea was cultivated, under FP6, with the series of MERA preparatory projects, iMERA, and under FP7 iMERApplus, and culminated in the EMRP Programme.

The construction of an optimal infrastructure is not, in itself, a research goal, yet research may play a role, since NMIs are typically involved in research, such as the advancement of individual SI primary or in the improvement of the SI as a whole system. EMRP moving in this direction did provide a contribution in the scope of ERA.

EMRP also pursued two additional main goals, namely

- To support the National Measurement Systems (NMSs), and
- To contribute to societal needs, especially by addressing grand challenges (environment, energy and health, new technologies, security).

Analysis and conclusions

The Expert Group agrees that the EMRP provided a significant contribution to the initial goal of contributing to the development of a European Infrastructure for Metrology. It was less successful in respect to the other two main goals, supporting the NMSs and contributing to the grand challenges. The main reason for this less satisfactory result was due to the overall structure of the programme, which was *too closed*.

We therefore essentially agree with the observation made in the mid-term evaluation report that *“the scale of the EMRP seemed sufficient to create a genuine core ERA in metrology but it would have to become inclusive of the wider research community to be the platform for a true European Research Area in metrology”*.

As this programme is now closed but the follow up programme EMPIR has similar overall goals, the Expert Group has made recommendations for the follow up programme.

2.7 IMPACT IN TERMS OF ADDED VALUE OF THE EMRP PROGRAMME

For a clear understanding of the meaning for “Impact in terms of Added Value” , this section starts with definitions from literature because it is not defined in the programme documents.

A widely accepted definition for “impact” is available from OECD: “Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.” [OECD 09].

Metrology’s impact is task of many studies. Collections of links are currently available on [BIMP Impact 16] and [PTB Impact 16]. [Rob 2015] summarises the content of the current literature referring to economic impact. The results vary depending on the application and the type of analysis.

Nevertheless, there is a common understanding that **metrology performance has an impact on everybody’s daily life and on trade and business**. This is also mentioned in the introduction of EMRP’s basic act [Law EMRP 2009] “Reliable and comparable measurement standards, and **appropriate validated measuring and test methods underpin the processes of scientific advancement and technological innovation and thus have a significant impact on the economy and quality of life within Europe.**”

The impact should be seen in the context to the “European Added Value (EAV).” But there is also no common definition for EAV.

Already EMRP’s interim report [Int Report EMRP 2012] mentions the missing definition for EAV: “While there is no clear definition of what the term entails, it most often draws on ‘additionality’ sources or critical mass arguments, ‘subsidiarity’ argumentation, and on the complementary nature of EU funding.”

This understanding is similar to the definition in the European Commission’s report about “European Added Value of EU Science, Technology and Innovation actions and EU-Member State Partnership in international cooperation” [Technopolis 2014]: “EAV is a multifaceted and changing concept that can only be understood by relating drivers and objectives of actions to outputs and impacts, and by assessing the additional benefit of collective actions compared to national or ‘private’ actions.”

Therefore, we can say that the impact in terms of European added values means additional impact from collective efforts, compared with action by Member States.

The expectations to the European metrology initiatives were task of two impact assessments in 2008 and 2013.

The impact assessments from 2008 [IA 2008] referring to EMRP describes the so called “metrology dilemma”: “The demands for metrology research is growing both in the traditional industries as well as in new technology based industries. They are growing at a rate that needs a significant change in the organisation of metrology as well as a significant increase in the budgets for metrology research.” A dedicated programme for metrology based on Article 169 seems to be the best solution to overcome this dilemma because it enables the EU to participate in research

programmes undertaken jointly by several Member States, including participation in the structures (NMIs and DIs) created for the execution of national programmes. The dedicated programme will generate reduction of overlaps and duplications to release additional resources for research activities. The impact assessment provides a list of specific indicators to review the achievement towards the objectives at operational level. These indicators and the achievements are presented in section 2.2.

The ex-ante impact assessment for EMPIR is described in section 3.8.

The results of the public consultations can be seen also as an indicator for impact of the programmes. So far three public (web based) consultations in 2008, 2012 and 2016 were performed during the period of EMRP and EMPIR. They approve the need for more cooperation in European's metrology research activities, the need to increase the investment into metrology research and the relevance of the initiatives. The number of participants varies between 160 (2008) and 650 (2012). The majority of participants were from research organisations and national administration.

However, the main sources for the definition of the expectations to impact and the referred European added value of the programmes are the above mentioned ex-ante impact assessments. They describe the objectives that are already defined in the basic act and the corresponding general/delegation agreement and they add indicators for the operational objectives. Objectives, indicators and the achievements are described in the sections before. The following sections refer to dedicated actions for impact only.

A summary of the impact assessment methods from EURAMET for EMRP and EMPIR is presented in [Knee 2016a]. The base is a data collection as part of the standard project reporting that must be considered already during project planning. EURAMET developed templates to identify the data and plan the collection for reporting [Knee 2016b]. Due to the presentation of the template mid 2016 there are no experiences available so far. Therefore, EURAMET's Management Support Unit mainly collects the information about impact through surveys and the evaluation of projects reports.

The formal procedure to collect data for impact leads to an "over-focus" on operational objectives and their indicators [Knee 2016b].

EMRP's basic act defines impact as a core evaluation criterion [Law EMRP 2009]. Therefore, the general agreement [General Agree EMRP 2009] requests an ex-post impact assessment by the end of 2017.

The achievements against EMRP's objectives are described in section 2.2. Additionally, EURAMET published impact reports and impact case studies.

So far, there are three impact reports for the Energy, Environment and Industry available and a draft report for Health. The published versions are available in the "Metrology for Society's Challenges" section of EURAMET's web page (<https://www.EURAMET.org/metrology-for-societys-challenges/>). They present the "result highlights" of the different projects on one page (see figure). Furthermore, the report contains an overview about achieved indicators for operational objectives and a collection of examples for impact from different projects. The reports demonstrate in a reader-friendly way EMRP's impact.

Examples for result highlights from the industry impact report⁴:

- Total investment: EUR 54 million
- 96 businesses involved
- 46 academic groups involved
- Pooling experts of 28 NMIs/DIs from 22 European countries plus the NMIs from USA, Japan, Korea, Brazil, and Argentina
- 96 presentations at workshops and seminars, reaching 12 000 people
- 19 published newsletters and press releases
- 841 presentations at conferences
- 224 articles in peer-reviewed journals
- 84 training courses delivered to over 3 000 people
- 97 contributions to 47 technical committees and working groups of standards organisations
- 23 articles in the trade and popular press
- Supported the development of improved instrumentation with projected sales of EUR 93 million

For several projects, there are project specific impact case studies available on the same web pages. These case studies are designed in similar way.

The web page mentions that all these papers describe early impact. Activities to evaluate long term impact are not visible. This is not beneficial also against the background that research's impact may have a long-term perspective. This is pointed out in [ERA-LEARN 2016]: "At the same time impacts from research may take 20 or even 50 years to become visible thus necessitating a long-term perspective in P2P impact assessment."

The requested differentiation into impact on European, National/Regional and International level according to the terms reference is difficult to answer. Due to the "Joint character" of the projects, the impact has in most cases a European dimension and that fits to the above-described European Added Value context. That means that project results effect standardisation and collaboration between research organisations. This is obviously visible by the large number of contributions to standard organisations in the Energy and Environment call. The large number of training courses and businesses of the Industry call have more National/Regional character because regional organisation or companies implement them. The international level of impact is mainly achieved by the integration of international NMIs and other organisations.

⁴ <https://www.euramet.org/metrology-for-societys-challenges/metrology-for-industry/>

3. EMPIR

3.1 OVERVIEW OF EMPIR

Aims and objectives

The objective of EMPIR is to support the provision of appropriate, integrated and fit-for-purpose metrology solutions and the creation of an integrated European Metrology Research system with critical mass and active engagement at regional, national, European and international level that cannot be sufficiently achieved by the Member States alone. It is comparable to EMRP with a stronger focus on exploitation [Delegation Agree 2015].

The EMPIR aims to support metrology research in any technological, industrial field, but does not explicitly state it also supports commerce. It will do this by providing the legal and organisational framework required to support large scale European co-operation between Member States, by funding projects that can tackle the significant new technological and scientific challenges facing the metrology community and encouraging exploitation of these results.

The core activity is funding trans-national EMPIR projects which address research, technological development, plus training and dissemination activities. The core part of the projects shall be undertaken by National Metrology Institutes and Designated Institutes responsible for certain national standards not covered by the National Institutes, but other organisations are also able to participate, unlike in EMRP.

Structure and activities

In accordance with the agreement between the Member States and the European Community under the Horizon 2020 programme, a dedicated implementation structure had to be formulated that would take responsibility for the implementation of the EMPIR programme. The European Association of National Metrology Institutes, EURAMET, was established by the Member States to undertake these activities in 2009 and remains active for the EMPIR to continue with these activities. It is governed by the Member States.

EURAMET is responsible for the launch for calls for proposals, evaluation of the proposals, awarding the funding to chosen proposals, ensuring the projects are run in accordance with the guidelines and the handling of the funding from the Member States and the community to these projects when they achieve their goals.

Funding and financial integration

At the outset twenty eight participating Member States have agreed to make a financial contribution of a minimum of EUR 300 million. Any other member state and any country associated with Horizon 2020 should be entitled to join the EMPIR provided they make a financial commitment to the programme.

The Community financial contribution will match that of the Member States, but is subject to commitments of resources from the Member States and payment of their financial contributions. It is also dependent upon a dedicated implementation structure which is the responsibility of the Member States to establish and execute the EMPIR. This structure would be the recipient of the Community financial contribution and ensure efficient execution of the EMPIR. The Community has a right to reduce, withhold or terminate its contribution if the EMPIR is not implemented adequately or funds from the Member States are inadequate or late.

The funding of projects should be transparent, with the evaluation of proposals performed centrally by independent experts.

It was a requirement that the Commission conduct an interim and final evaluation to assess the quality and efficiency of the EMPIR.

EURAMET is entirely responsible for the implementation of the EMPIR programme.

3.2 EMPIR: OBJECTIVES AND ACHIEVEMENTS AGAINST OBJECTIVES

EMPIR objectives are defined in

- Decision 555/2014 [Law EMPIR 2014]
- EMPIR's Delegation Agreement [Delegation Agree 2015]

The General objectives for EMPIR are defined in the annex I of the basic act for EMPIR [Law EMPIR 2014]:

GO1 *Provide appropriate, integrated and fit-for-purpose metrology solutions supporting innovation and industrial competitiveness, as well as measurement technologies addressing societal challenges such as health, environment and energy, including support to policy development and implementation;*

GO2 *Create an integrated European Metrology Research system with critical mass and active engagement at regional, national, European and international level.*

There are no indicators defined for the general objectives. The indicators for the specific objectives according to the following sub-section below are connected to the general objectives and defined indirectly indicators for the general objectives.

Referring to EURAMET's research agenda [Euramet Research Strategy 2016] it is clear that the general objectives compare to EURAMET's major challenges currently facing European metrology. They also form a base for the following specific and operational objectives. For the second general objective, it is challenging to reach an integrated European Metrology Research System and EMPIR, and EURAMET is playing an important role. EMPIR's delegation agreement [Delegation Agree 2015] derives concrete specific and operational objectives.

Specific objectives and progress against objectives

The five specific objectives define quantitative indicators. They are grouped according to the impact assessment [IA 2013] with two headlines that correspond to the two general objectives above:

The definition of the specific objectives and the achievements according to EURAMETS's report for EMPIR are discussed below. The objectives are grouped according to the headlines.

(a) Boost industrial uptake and improve standardisation

S2.1 European Turnover: At least EUR 400 million of European turnover from new or significantly improved products and services that can be attributed to the research activities of EMPIR and its predecessors

Based on surveys of industrial participants in EMRP the participants expect EUR 463 million sales of products influenced by the program. Early adopters estimate that EUR 109 million is directly attributable to the programme. This figure covers the industrial participants who participated in projects in the first two EMRP calls (covering the Energy, Environment and Industry themes) [EMPIR Input Interim 2016]. The statements referring to EMRP give only an outlook that the expectations are reasonable. Therefore the achievement is still open, but it looks promising.

S2.2 Standardisation: At least 60% of CEN/CENELEC /ISO/IEC Technical Committees and equivalent standardisation bodies with potential to benefit directly from EMPIR projects to engage with the programme

This engagement is tracked and reported by the EMPIR reporting processes. It is too soon to report the extent of this engagement but preliminary results are available. Also, to the end of 2015, EMRP projects had made 739 contributions to 379 unique standards committees, resulting in contributions to 17 published and 103 draft standards [EMPIR Input Interim 2016]. There is a reference for 60 % of CEN/CENELEC /ISO/IEC Technical Committees and equivalent for EMPIR. This achievement requires a definition for the reference to determine 60 % of CEN/CENELEC /ISO/IEC Technical Committees and equivalent standardisation bodies.

(b) Underpin a coherent, sustainable and integrated European metrology landscape to fully exploit the EU potential

S2.3 Investment: Maintain a level of at least 50% of dedicated national metrology research investments in Europe being coordinated or influenced via the programme

For 2015, 18 states participating in EMPIR have assessed their joint national research budget as EUR 166 million. The annual value (to the NMIs and DIs) of the research projects commissioned by EMPIR is EUR 68.571 million (EUR 30 million from the EU and EUR 38.571 million as in kind funding from the national budgets) [EMPIR Input Interim 2016]. The reference for the 50% is not defined. Furthermore, there is no common definition for national metrology research investments. The report presents these difficulties clearly. This cannot be evaluated whilst there is no definition to evaluate the national metrology research investments. EURAMET plans a survey for a more comprehensive evaluation of this objective [EMPIR Input Interim 2016]. This approach sounds reasonable.

S2.4 Interaction: All European NMIs and their designated institutes interact with the programme

All EURAMET members have a place in a funded JRP. There are reasons given for a few exceptions [EMPIR Input Interim 2016].

S2.5 Metrology Committees: European leadership in at least 20% of international metrology committees

Of the 70 chairs and vice chairs of the working groups of the CIPM Consultative Committees, 36 come from European NMIs and DIs.

It must be considered that all the statements about the achievements above are preliminary because no projects have finished yet. This becomes obvious when looking at the achievement for the first specific objective. The survey result gives a very rough estimation and the outlook sounds promising.

Furthermore, the third objective has no reference definition for the dedicated national metrology research investments. Under these circumstances it is not possible to determine the part of the national metrology research investments being coordinated or influenced via the programme. EURAMET's report presents these difficulties clearly.

The fourth and fifth objectives are achieved and it can be expected that this level can be maintained until the end of the programme.

Operational objectives and progress against objectives

The operational objectives that are defined in EMPIR's delegation agreement [Delegation Agree 2015] are connected to performance indicators according to the following table. These indicators are defined in EMPIR's impact assessment [IA 2013]. Additionally, the EC (European Commission) added further indicators. The TARGET comes directly out of the delegation agreement.

| OPERATIONAL OBJECTIVES | | INDICATORS |
|------------------------|--|--|
| OO1 | Common agendas: Establish common agendas with strong integration of basic as well as challenge-oriented metrology research via common priorities and joint calls with excellence based projects selection | <ul style="list-style-type: none"> • % of EMPIR research budget as part of total NMI/DI research budget (N.B. This is covered by target of 50% for S2.2) • % "Perceived influence" of EMPIR on national research agendas • # of publications in refereed journals • # of publications in non-refereed journals incl. books, conference proceedings • % of the above with co-authors from more than one country • % of projects involving wider science community • % of person month and % of budget allocated to wider science community • # of different organisations involved in the programme (non-NMIs/DIs) • % split of research investments for different research areas <p>ADDED BY EC (Horizon2020 KPIs)</p> <ul style="list-style-type: none"> • # of joint public-private publications • # of citations, after 1 to 5 years; Citation index of peer-reviewed publication • # of citations of Horizon 2020 project in EURLEX <p>TARGET - for participation of non-NMI/DI scientists in the programme) (from Proposal for a Co-Decision): <i>Double compared to EMRP</i></p> |
| OO2 | Innovation: Support innovation related activities through the development of new technologies, industry- driven joint research projects and industrial uptake. This requires a systematic technology screening of projects and at least 20% industry driven research. | <ul style="list-style-type: none"> • # of companies (incl. SMEs) participating in EMPIR projects • % of EMPIR projects with industry participation • Value of business investment in EMPIR projects, ' of person month • # of patents (applied for / granted) • # of licence agreements • # value of products and services coming from innovation projects (N.B. This is covered by target of EUR 400 million for S2.1) <p>ADDED BY EC (Horizon2020 KPIs)</p> <ul style="list-style-type: none"> • # of projects with new innovative processes, products, instruments, methods, technologies, or prototypes • Share of participating firms introducing innovations new to the company or the market (covering the period of the project plus three years) • Patent applications and patents awarded in the different enabling and industrial technologies <p>TARGET for industrial participation: <i>At least 20% industry driven research (no dedicated module under the present EMRP)</i></p> |
| OO3 | Normative research: Increase immediate relevance for policy | <ul style="list-style-type: none"> • % of EMPIR budget programmed in partnership with standardisation |

| | | |
|-----|---|---|
| | makers and standardisation bodies. At least 10% is dedicated to normative research. | <p>/regulation</p> <ul style="list-style-type: none"> # of projects with direct references or impact on standards and regulation, percentage of CEN and ISO projects % of EURAMET working groups with relevance for standardisation bodies <p>ADDED BY EC (Horizon2020 KPIs)</p> <ul style="list-style-type: none"> Contributions to standardisation activities; Exploitable results used, standard body (CEN, ISO, NSB) <p>TARGET – for normative research activities: <i>At least 10% is dedicated to normative research, compared to 0% in EMRP</i></p> |
| 004 | Participation: Open the programme to the relevant scientific communities and raise awareness and involvement of European technology and research organisations. This means to at least double the participation of non NMI/DI scientists in the programme compared to EMRP | Common indicators with OO1 |
| 005 | Capacity building: Support capacity building in developing NMIs, in particular by assisting national authorities to fully exploit the use of structural funds and other relevant programmes. The expectation is to increase the leverage of EU structural funds and other programmes, from 0% under EMRP to 10% of the co-investment in EMPIR. | <ul style="list-style-type: none"> # of Member States and third countries involved in EMPIR with financial commitment Increased capacities in MS with low level of metrology capacities, e.g. shown by their involvement in committees and projects Value of Structural Funds invested in metrology-related activities # of mobility grants, post docs, doctoral students, postgraduates, guest scientist # of calibrations with new capacities <p>ADDED BY EC (Horizon 2020 KPIs)</p> <ul style="list-style-type: none"> # of experienced researches, new researches with PhD, PhD students <p>TARGET – for leverage of structural funds: <i>Increase the leverage of EU structural funds and other programmes, from 0% to 10% of the co-investment in EMPIR</i></p> |
| 006 | Global Co-operation: Strengthen European Leadership through EURAMET and foster global co-operation. It should lead to at least two structured co-operations with major metrology actors outside Europe (e.g US, Canada) | <ul style="list-style-type: none"> # of unfunded participants from 3rd countries % of EU leadership in committees <p>TARGET – for leadership: <i>At least two structured co-operations with major metrology actors outside Europe (e.g. US, Canada)</i></p> |

The following summarises the achievements according to EURAMETS's report for EMPIR. Only the performance indicators from the delegation agreement (TARGETs) are considered so far in the annual reports [EMPIR Annual Rep 2015/2016, EMPIR Input Interim 2016].

OO1 Common agendas: Establish common agendas with strong integration of basic as well as challenge-oriented metrology research via common priorities and joint calls with excellence based projects selection

A key element of the common research agenda for both EMRP and EMPIR is a thematic structure with a strong and direct focus on metrology to address the grand challenges rather than the traditional approach to metrology research focused on technical areas and/ or SI units [EMPIR Input Interim 2016].

EMPIR calls are designed around the themes, referred to as TPs (Targeted Programme) in EMPIR, and the call scopes are based on the content of the European Strategic Research Agenda (SRA) for the EMPIR period developed 2015 [Euramet Research Strategy 2016]. The TARGET refers to OO1 and OO4 according to ex-ante impact assessment 2013 [IA 2013] and its achievement is described at OO4.

OO2 Innovation: Support innovation related activities through the development of new technologies, industry- driven joint research projects and industrial uptake. This requires a systematic technology screening of projects and at least 20% industry driven research.

The Industry calls (in 2014, 2017 and 2020) have a total budget (EU contribution) of EUR 62.1 million. In addition, industrial participation is encouraged under the different grand challenge themes, such as health, energy and environment.

This is 20.7 % of the EUR 300 million total.

- Of the contracts issued so far, 35% by value has been for the industry theme.
- Of the contracts issued so far, 7% of the estimated costs belong to industrial beneficiaries
- 40% of these are funded and 60% are unfunded.
- Of the contracts issued so far, 28% of the legal entities involved are industrial.

OO3 Normative research: Increase immediate relevance for policy makers and standardisation bodies. At least 10% is dedicated to normative research.

For the contracts issued so far, the estimate is that 17% of the effort is dedicated to normative research.

OO4 Participation: Open the programme to the relevant scientific communities and raise awareness and involvement of European technology and research organisations. This means to at least double the participation of non NMI/DI scientists in the programme compared to EMRP

Of the EMPIR contracts issued so far, the external funded participants estimate the funded effort to be 2387 months. If we scale this up to the full value of EMPIR (x 300/65) we can estimate 11017 months. This represents an increase of 1.92 times the months in EMPIR compared to EMRP (5740 months). According to the calculation, this achievement is close to its target.

OO5 Capacity building: Support capacity building in developing NMIs, in particular, by assisting national authorities to fully exploit the use of structural funds and other relevant programmes. The expectation is to increase the leverage of EU structural funds and other programmes, from 0% under EMRP to 10% of the co-investment in EMPIR.

Capacity Building is supported through a range of training activities and a Mobility Grant scheme, all funded from the cash contributions. Despite much work on seeking routes to influence the direction of structural funds, no common systematic approach has been discovered. It is not clear what the strategy is to reach this objective.

OO6 Global Co-operation: Strengthen European Leadership through EURAMET and foster global co-operation. It should lead to at least two structured co-operations with major metrology actors outside Europe (e.g. US, Canada)

No progress has been made on this objective yet.

Conclusions

The EMPIR Programme was a successor to EMRP and the strategy was to support research in measurement and metrology in the EU.

There were two main goals:

- To support European National Measurement Systems, with the vision of a shared infrastructure throughout Europe, and
- To contribute to economic and societal grand challenges facing the EU.

In addition there were a number of specific and operational objectives, which have been discussed in the previous section.

Overall it is recognised that good progress has been made towards the majority of objectives and the experts are confident that the programme can achieve its objectives.

However, the experts do believe that there are areas where improvements can be made, particularly relating to those objectives where progress is less than expected at this stage in the programme.

For clarity, the areas where the experts feel the programme could improve have been identified and recommendations provided against these objectives.

GO1 Provide appropriate, integrated and fit-for-purpose metrology solutions supporting innovation and industrial competitiveness, as well as measurement technologies addressing societal challenges such as health, environment and energy, including support to policy development and implementation.

The Grand Challenges are set by groups without formal structure or procedures or voting rights. Furthermore, as they are only from NMIs, and hence lack the industrial and academic breadth and depth of knowledge within these broad topics. The review process is run by EURAMET who have well documented and controlled procedures in place, but at this point the decision has already been made as to what the topic is, so the review is already strongly biased. This is not the case under the main Horizon 2020 programme where the topics are far broader and the reviewers come from a wide range of disciplines.

There is also minimal interaction between the EMPIR programme and Horizon 2020 or other associated initiatives. The metrology community feel that their topics do not overlap and the general consensus is also that the EMPIR projects are easier to obtain than Horizon 2020 projects and therefore the vast majority of their effort is put in to obtaining EMPIR projects rather than Horizon 2020. This serves to separate the metrology community from the rest of the EU R&D activities, which is not considered beneficial.

The experts make the following recommendation:

- 1) External industrial and academic partners need to be part of the programming process for selecting call topics and this could be by setting up a joint board with NMIs and external partners. EURAMET also needs to have a means of assessing their outputs, as these lead to project topics where the formal review process begins.

GO2 Create an integrated European Metrology Research system with critical mass and active engagement at regional, national, European and international level.

Considering the current state of development, we note that the positive aspects of EMPIR are that the NMIs are working on projects together and building a stronger metrology research community across Europe. However, there is no clear plan to generate an ***integrated European Metrology Research system*** with critical mass and active engagement at regional, national, European and international level.

There appears to be strong links with the EU community in the core metrology topics, primarily relating to physical measurements. However, there are applications which require support in metrology that have not yet been fully addressed, for example those requiring chemical or biochemistry input.

Furthermore, a strategy for creating measurement standards "excellence centres" across Europe is needed, targeting an assessment for each SI unit to avoid unnecessary multiplication, whilst still building and developing expertise across Europe. This would reduce current overspending for over-multiplying measurement standards in Europe and bring a balanced and economically viable system in Europe for ensuring measurement traceability for all SI units. Whilst this may be difficult to achieve within the programme, the experts have the following recommendations:

- 2) to help establish a more integrated measurement society within Europe:
 - a) Set up a task force within EURAMET to address how they may achieve the goal for an EU integrated measurement society within the period of EMPIR. A plan needs to be set and approved by 2018 and should include external experts other than Directors of NMIs and EURAMET.
 - b) To take further measures to reduce the gap in metrology research across Europe, future calls should focus increasingly on areas where research is needed to support implementation emerging policy needs, such as linking it to European legislation. This could include measurements of various parameters, for example chemical and bio-chemistry applications linked to the Water Framework Directive.
 - c) Broaden and increase the involvement from the all European NMIs in the programme, by ensuring that funding options also facilitate the hiring of new staff for the research projects. Specific skills should be developed at a national level and shared across the EU and smaller NMIs should be encouraged to enter developing research areas. National ministries should take the necessary steps to provide the NMIs with the flexibility to fully use the resources and opportunities made available within EMPIR for the execution of their activities.

S2.1 European Turnover: *At least EUR 400 million of European turnover from new or significantly improved products and services that can be attributed to the research activities of EMPIR and its predecessors*

In order that this can be followed up in the future and participants are aware of the need for a longer term impact, the experts recommend:

- 3) To improve the impact from existing and future projects
 - a) For all funded projects the impact evaluation has a long-term component. This could form part of the evaluation criteria.
 - b) The accessibility of impact information on EURAMET's web page should be centralised with a specific access page for impact. Currently it is structured according to the calls and makes it difficult for organisations outside EMPIR and EURAMET to easily access.

O2.1 Common agendas: *Establish common agendas with strong integration of basic as well as challenge-oriented metrology research via common priorities and joint calls with excellence based projects selection.*

There was some concern that topics were being chosen without a strong industrial or societal need. The experts therefore recommend:

- 4) The target for the research for SI units is the reduction of uncertainty. In any future proposals on this topic the requirements for uncertainty and the corresponding costs for traceability of uncertainty should be supported by a clear driver from industry or society. This recommendation is linked to the impact recommendation above, and could form a part of the evaluation criteria.

O2.5 Capacity building: *Support capacity building in developing NMIs, in particular by assisting national authorities to fully exploit the use of structural funds and other relevant programmes. The expectation is to increase the leverage of EU structural funds and other programmes, from 0% under EMRP to 10% of the co-investment in EMPIR.*

This is considered an unachievable target for a number of reasons. The onus is put on the smaller NMIs who are more likely to be in regions where structural funds are available. However, the smaller NMIs only have a small percentage of the overall EMPIR budget, so the expectation is they will have to achieve significant funding from structural funds. Structural funds also require considerable effort to attain and it seems like an unnecessary additional burden to place on NMIs.



from non-NMIs and non-DIs partners, mentioned above as one of the main progresses of EMRP in respect to EMPIR.

Stage 2, the launch of the call, took place from June to September. The management of this process was in line with the EURAMET guidelines.

The time from the call closure in end of September until the publication of results was about 3-4 months, giving a publication in January or February. This includes a central review conference, as under EMRP, and the approval of the ranking lists by the EMPIR Committee. The grant preparation phase has also been reported to be completely finalised before the end of May, respecting the Horizon 2020 target of below 8 months.

Governance

The Programme has been managed in a generally efficient way. The refereeing process was governed according well established and effective EC rules, the production of documentation and promotional material was appropriate. The management and monitoring procedures for the funded projects is considered acceptable and there are no recommendations to make any changes.

Discretionary activities supporting links to standardisation, capacity building and innovation were also properly executed.

Supervision

It is considered that EMPIR has insufficient input to the initial phase of the process of choosing topics. The task groups have the responsibility of proposing call scopes for the EMPIR Committee to consider and these individuals are not voted in and their skill level is not defined. The documentation of this phase of the work plan preparation is not complete, nor the process of stakeholder consultation during the deliberations of these groups. This aspect can be improved within EURAMET.

With respect to the running of the programme, and the related decision making protocols, the Expert Group believes that they have good procedures in place and do not recommend any changes.

Conclusion

Overall, the Expert Group believe that EURAMET is managing the EMPIR programme efficiently. However, there are two areas of concern, both of which have resulted in recommendations described in the achievements against objectives.

It is recommended that, in regard to the addressing of grand challenges for measurement, external industrial and academic partners should be included in the programming processes from the outset.

Similarly, concerning the goal of establishing a European infrastructure for measurement, a task force, including both NMIs and external partners should be constituted to monitor such a process.

3.4 RELEVANCE AND APPROPRIATENESS OF EMPIR

EMPIR was established to help strengthen the metrology community in Europe and build on the success of the previous Art 185 programme EMRP. In the objectives two clear strands to the programme were defined, one relating to projects and the second to the metrology community.

The EMPIR programme provided a framework for the national NMIs to work together on fundamental metrology topics such as the development of enhanced SI measurements, as well as metrology projects for industry, which addressed both aspects. The main difference between the predecessor programme was the extended funding for non NMI participants.

Interviews were conducted with Directors of NMIs, EURAMET Board Members and project managers. It is fair to say that from these interviews there was 100 percent support of the programme and a desire for it to continue. The reasons for this differed slightly between the individuals, but there were some themes that were common to all:

- The programme provides additional funding for their research and this was positive.
- There is greater sharing of expertise between NMIs, primarily within projects.
- They have more involvement with industry.

When questioned on the integration of the NMIs to form a European Metrology Research system, there was general agreement that each country wished to retain its own independence regarding its metrology services and was happy to carry out research across borders. The consensus was that:

- national metrology services must remain
- research expertise was not going to be consolidated or topics specified for different countries

Whilst it is accepted that governments may require specific metrology services in their country, it is not possible to achieve an 'Integrated European Metrology Research system with critical mass' if the countries are not prepared to jointly agree on how research will be shared.

Therefore, whilst the EMPIR programme is considered relevant, the programme structure is not formulated to accommodate an integrated community. EURAMET must establish and agree a programme with the NMIs that will result in an integrated solution. This is seen as a contentious issue but does need to be resolved, having first being raised in the EMRP mid-term review.

Regarding the delivery of 'Integrated and fit for purpose metrology solutions plus measurement technologies addressing societal challenges', the former is clearly within the remit of metrology and where the NMIs offer excellent value. The latter is where measurement technologies are developed by the wider scientific community exploring new concepts. The difficulty is agreeing where the line is between a new research topic and a well understood and defined problem that requires an innovative measurement solution. The system in place is not robust enough to ensure that all the projects are appropriate for the EMPIR programme rather than the broader Horizon 2020 programmes. Recommendations to address this have been provided in section 3.3.

In summary, it can be considered that the aims of EMPIR are still appropriate and relevant but are not fully achievable with the current structure.

3.5 ASSESSMENT OF THE INDIRECT COSTS

From the discussions at the interviews it was clear that different countries had different views on the overhead rate allowed under EMPIR. It is lower than the overhead rate of any NMI and considerably lower for the larger, more established ones, such as those in the UK and Germany. This effectively means that national governments must subsidise the shortfall in overheads and the result is that the programme costs slightly more than the matched funding as stated. This does not appear to have caused any country to be unable to participate but it may have reduced the likeliness of countries increasing their contribution from the agreed amount. It also does not help making the gap between advanced and emerging NMIs smaller. Overall, as the programme appears to be considered by all national governments to provide positive incentive to increase R&D in metrology they have accepted the lower overhead rate. However, if it were closer to their actual over-headed rate it may encourage increased national commitment.

In addition, the matched funding overall depends on the indirect costs supported by the Participating States. The 5% indirect flat rate funded by the EU contribution to the internally funded partners is subject to if the NMIs can demonstrate average total indirect costs of at least 140% of the direct costs (of the 10 largest NMIs). At this point in time, the current overhead costs is reported to 141.6%.

It is therefore concluded that the indirect costs are adequate and the 5% contribution to the indirect costs by the EU funding do not require changing within this programme.

3.6 COHERENCE WITH OTHER INITIATIVES WHICH ARE THEMATICALLY RELATED

The coherence of EMPIR with other EU policy instruments

There is a number of different EU funding schemes where aspects of the objectives and the societal challenges are aligned to those of EMPIR and therefore should be considered when assessing the coherence of EMPIR with other EU policy instruments.

Horizon 2020

Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly EUR 80 billion of funding available over 7 years (2014 to 2020), plus private investment from the various Public- Private Initiatives. In this programme funding is for the following societal challenges:

- Health, demographic change and wellbeing;
- Food security, sustainable agriculture, marine and maritime research and the bio-economy;
- Secure, clean and efficient energy;
- Smart, green and integrated transport;
- Climate action, resource efficiency and raw materials;
- Inclusive, innovative and secure societies.

Co-ordination and Support Action (CSA) forms part of the Horizon 2020 programme. This specifically addresses 'Accompanying Measures' such as **standardisation**, dissemination, awareness-raising and communication, networking, coordination or support services, policy dialogues and mutual learning exercises and studies.

There is also a number of joint funding programmes with Horizon 2020 which are focused on innovation and one has partially overlapping objectives compared to EMPIR.

European Institute of Innovation and Technology

The European Institute of Innovation and Technology (EIT) is an integral part of Horizon 2020. It is an independent EU body set up to enhance the EU's ability to innovate by nurturing entrepreneurial talent and supporting new ideas. The EIT has set up a number of Knowledge and Innovation Communities (KICs) around Europe, with each one focusing on a specific societal challenge:

Climate, Digital, InnoEnergy, Health, Raw materials, Food

Planned: Added-value manufacturing and urban mobility

European Innovation partnerships

European Innovation partnerships (EIPs) are fully funded within the Horizon 2020 programme. They act across the whole research and innovation chain, bringing together all relevant actors at EU, national and regional levels to: (i) step up research and development efforts; (ii) coordinate investments in demonstration and pilots; (iii) anticipate and fast-track any necessary regulation and standards; and (iv) mobilise 'demand' in particular through better coordinated public procurement to ensure that any breakthroughs are quickly brought to market. The aim of the EIPs is to design and implement these activities in parallel to cut lead times. Their topics are more overarching than the grand challenges:

Active and healthy ageing, Agricultural sustainability and productivity, smart cities and communities, water and raw materials

European Joint Programme Cofund,

European Joint Programme (EJP) Cofund is a co-fund action under Horizon 2020 designed to support coordinated national research and innovation programmes. The EJP Cofund aims at attracting and pooling a critical mass of national resources on objectives and challenges of Horizon 2020 and at achieving significant economies of scales by adding related Horizon 2020 resources to a joint effort. It addresses the same societal challenges as Horizon 2020.

For completeness, the EMPIR grand challenges are:

Health, Energy, Environment. In addition, there are calls for: Industry, *Fundamental Metrology* and Standardisation, where only Fundamental Metrology is not covered by Horizon 2020.

Analysis and conclusions

From the description of the related EU programmes it is clear that the societal challenges identified in Horizon 2020 and other related programmes overlap with EMPIR, with only fundamental metrology unique to EMPIR. All of these programmes have a strong research focus where measurement would play a key part and they are more inclusive to the wider measurement community. The EURAMET team should have liaised with these other programmes in order to ensure there was coherence with their projects, minimal overlap of the topics and the breadth of expertise was sufficient from the NMIs to drive these chosen EMPIR projects. For wider topics they should have encouraged partners to explore these complementary programmes. In the documentation provided there was no evidence that EURAMET has developed a strategy to address these points. The result is that some EMPIR projects may not include sufficient expertise from the wider measurement community and these topics would have been better addressed under one of the other programmes.

It was also apparent from the interviews that EURAMET were not pro-active with the other relevant EU programmes funded or part funded under Horizon 2020. From the interviews, it was clear that many EURAMET members and NMIs and DIs did not consider other programmes for funding. Also there was no evidence of any interaction between EURAMET staff and the EMPIR members with Horizon 2020 personnel for any of the themed calls, where the topics are the same.

There is also no clear evidence of dissemination or collaboration between EMPIR and the wider Horizon 2020 programmes.

3.7 EFFECTIVENESS AND CONTRIBUTION TO THE GENERAL POLICY OBJECTIVES

Evolution in underlying scenario

In 2010 the European Commission developed a 10-year strategy for advancement of the economy of the European Union, named Europe 2020, and following the Lisbon Strategy for the previous period [Europe 2020] [Europe 2020 web]. It aims were "smart, sustainable, inclusive growth" with greater coordination of national and European policy. It defined target values for social goals in the perspective of 2020, including:

- To raise of the employment rate of the population aged 20–64 from the current 69% to at least 75%,
- to achieve the target of investing 3% of GDP in R&D in particular, by improving the conditions for R&D investment by the private sector, and develop a new indicator to track innovation.
- To reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are right, increase the share of renewable energy in final energy consumption to 20%, and achieve a 20% increase in energy efficiency.
- To reduce the share of early school leavers to 10% from the current 15% and increase the share of the population aged 30–34 having completed tertiary from 31% to at least 40%.
- To reduce the number of Europeans living below national poverty lines by 25%, lifting 20 million people out of poverty

In this context, the new framework programme, Horizon 2020 [Horizon 2020], took place, as a major tool for implementing that strategy, to which research was expected to provide a decisive contribution. Launched in January 2014, it is a **7-year research programme, with a budget of 80 billion Euro, plus the related** private and national public co-funding, aimed at:

- strengthening **the EU's position in science**
- strengthening **industrial innovation**

- address **major social concerns**, such as climate change, sustainable transport, renewable energy, food safety and security, ageing populations.

In pursuing such goals, it seeks to:

- ensure technological breakthroughs are developed into **viable products** with real commercial potential
- step up international cooperation on research & innovation including countries and organisations **outside the EU**
- further develop the ERA.

Therefore, in respect to the previous programme, the goals appear to move from structuring aspects - typically, the ERA - to pursuing excellence in science, providing support to industry and to addressing grand challenges. In this context, the EMPIR Programme was launched [Delegation Agree 2015].

Assessment of EMPIR in respect of the contribution to general policies

The objectives of EMPIR were stated as follows [Law EMPIR 2014]:

(a) "provide appropriate, integrated and fit-for-purpose metrology solutions supporting innovation and industrial competitiveness, as well as measurement technologies addressing societal challenges such as health, environment and energy, including support to policy development and implementation;

(b) create an integrated European Metrology Research system with critical mass and active engagement at regional, national, European and international level".

Although this Programme is generally seen as a continuation of the previous EMRP, important differences should be noted.

Support of NMSs is in the formulation of a "European Metrology Research system", where the focus is clearly on *research*. The aspect of contributing to enhancing (metrological) services, which is a distinctive feature of the NMIs, is no longer present.

Furthermore, the goal of contributing to facing economic and societal needs and challenges is now a defined aim.

The change of perspective is in agreement with the underlying change in the general policy: in FP7 the "structuring" aspect was possibly the main concern, whilst in Horizon 2020 the need to provide solutions to critical problems requires greater attention. This change of perspective is an important point for our evaluation.

Another important point is that in the development of EMPIR the comments of the Expert Group that produced the Intermediate Report for EMRP were considered in detail [Int Report EMRP 2012]. They are summarised as follows: "The overall opinion of the expert panel was that EMRP is a well-managed joint European research programme that has already achieved a relatively high level of scientific, management and financial integration. However, the expert panel also noted its limited industrial exploitation, limited opening to excellent science outside the metrology institutes and insufficient capacity building". As a result of these remarks, a major structural change was introduced, namely the possibility of research units other than NMIs or DI to participate to Joint Projects as funded partners.

Conclusions

The Expert group believes that the inclusion of research groups as funded partners in EMPIR was a major improvement over the previous EMRP and in line with the new trend of Horizon 2020. It is recognised that relevant competencies exist outside NMIs and DIs and these partners could help both improve research and help bring improved measurement methods to address the societal and industrial challenges.

3.8 IMPACT IN TERMS OF ADDED VALUE OF THE EMPIR PROGRAMME

An introduction concerning the definition of impact in term of (European) added value is presented in the impact section of the EMRP part (section 2.7). This section describes also the public consultations and the EURAMET's actions for the implementation of impact evaluation within JRPs.

The expectations of the EMPIR programme were the task of an ex-ante impact assessment in 2013 [IA 2013].

It addresses similar topics like EMRP's impact assessment [IA 2008]. It mentions the strong increase of national investment in metrology in China and US as a challenge for Europe's competitiveness. Furthermore, it describes underexploited potential to have a greater impact on growth and socio-economic challenges and fragmentation and structural weaknesses of the European metrology research and innovation system. Although the Article 185 (former Article 169) is an almost perfect instrument for joint programming within the metrology community, there are several shortcomings of EMRP like a limited opening of the NMIs to excellent science outside the NMIs and insufficient capacity building. Additionally, the lack of dedicated instruments to support innovation and regulatory/standardisation roadmaps limits industrial exploitation, and thus the broader economic impacts. Therefore, improvement from EMRP to EMPIR must consist of a stronger focus on innovation and industrial uptake, entirely new support for standardisation and dedicated capacity building, and links to other funding sources, such as structural funds, to support participating states with incomplete or emerging metrology systems, to allow them to close the gap with established metrology systems. This requests lead to a list of performance indicators for the operational objectives described in section 3.2.

EMPIR's basic act [Law EMPIR 2014] refers to the Horizon 2020 expectations regarding impact: "Horizon 2020 aims at achieving a greater impact on research and innovation by contributing to the strengthening of public-public partnerships". Additionally, the basic act requires: "EMPIR may support organisation of networking activities to promote EMPIR and maximise its impact." The delegation agreement [Delegation Agree 2015] asks for the programme's impact evaluation in the annual reports.

The requests to impact evaluation have a higher priority and are more detailed in comparison to EMRP. That leads to the above-described development of templates for providing information for the impact assessment (section 2.7). However, so far there are no impact reports or case studies available as no projects have finished yet.

A separate call "SIP" (Support for Impact) with a focus on dissemination and exploitation of activities refers to impact of the programme. SIPs must be based on research outputs from a completed iMERA-Plus, EMRP or EMPIR Joint Research Project. So far, these projects are not finished. The proposals for support for impact projects themselves might be an indicator for impact of projects. Further investigations why projects lead to SIPs and why not should be done.

The results of the public consultation were discussed already in section 2.7. It is disappointing that the number of participants decreased in 2016 to 250 replies in comparison to the 650 replies in 2012. It might be that the large number of public consultations from European commission reduces the interest in such consultations.

4. PANEL CONCLUSIONS AND RECOMMENDATIONS

Recommendations for the EMPIR programme

The following recommendations are made:

- 1) Increase the coherence and links with scientific research and policies at large:
 - a) EURAMET should involve external industrial, academic and research partners in the programming process when selecting call topics. Future calls should focus increasingly on areas where research is needed to support implementation of emerging policy needs, e.g. European legislation such as the Water Framework Directive, and the Directive concerning medical devices.
 - b) In order to broaden and increase the involvement and research capabilities of the NMIs the responsible ministries should take necessary steps to provide the NMIs with the flexibility to fully use the resources provided by EMPIR for the execution of their activities.
 - c) The European Commission services should ensure the coordination and coherence between the EMPIR activities and the relevant Horizon 2020 calls, including those supporting public-public or public-private partnerships.
- 2) To improve the impact from existing and future projects:
 - a) For all future funded projects the impact evaluation must have a long-term component, which could form part of the evaluation criteria. In addition, in the research for SI units the requirements for uncertainty should be supported by a clear driver from industry or society.
 - b) EURAMET should take the necessary steps to increase the accessibility of impact information on its web page, and it should be centralised with a specific access page for impact.
- 3) Support for further leverage capabilities
 - a) There should be an increase in Horizon 2020 programmes that NMIs are involved in. A goal could be set where 10% of funded projects that NMIs are involved in are funded through Horizon 2020. This may replace the goal of achieving 10% funding from the structural funds.
 - b) To establish a more integrated measurement society within Europe, EURAMET should set up a task force including external experts to further define the concept and advance the establishment of an EU integrated measurement society, including its global cooperation.

To sum up, the experts consider EMPIR successful, especially thanks to its greater openness compared to EMRP, and believe that further improvement in this direction is possible and necessary for a successor programme.

Recommendations for a successor programme

The experts strongly believe that there should be a follow up programme dedicated to measurement, as an independent discipline. Such a programme would greatly contribute to the general policy objectives of the European Union. This is also in line with the opinions expressed by the large majority at the stakeholder and public consultations.

When considering how this programme should be formulated it is important to refer to how research in measurement has been funded in the past. In the early framework programmes funding was provided to ensure all Member States could offer a measurement service to the same standard and make the EU more competitive. With the EMRP and EMPIR programmes the focus moved to metrology, which is a key topic within measurement. However, the main conclusion from these programmes was they did not include the wider measurement community sufficiently. The successor programme needs to address this with a more inclusive programme for measurement and encourage the Member States and their NMIs and the Commission Services to enter in to an open dialogue with all stakeholders, including academia, researchers and industry, on how best to achieve this. A future programme should be equipped with the means to better reflect and react to the evolving policy framework for research, innovation and education on the topic of measurement. This should be reflected in an adequate increase in budget and in the

structures and activities of a programme that goes beyond funding of projects and addresses the need to improve outreach and communication, in particular towards policy makers⁵.

A future European programme needs to be fully coherent with European and national policies. Participation should remain open to all those eligible for the Framework Programme. The limitation of the current Article 185 initiative is that participation is limited to national metrology agencies. Accordingly, the opportunity must be taken with the successor programme, whether under Article 185 or another instrument that supports joint funding with Member States, to open up the programme to the wider measurement community.

The experts are proposing a number of high level recommendations that a successor programme should take into account in order to establish a more comprehensive European Measurement society in full support of European competitiveness.

- 1) Strategic challenges in metrology and measurement
 - a) The NMIs, together with EURAMET and other stakeholders, should ensure that a future programme contributes a balanced and economically viable system in Europe for all SI units.
 - b) Centres of excellence for research in applications of measurement should be considered. These should not necessarily be coordinated by an NMI or a DI, but NMIs shall be strongly encouraged to be partners in such consortia.
- 2) Stakeholder participation
 - a) The programme should be further opened to include non NMIs on a greater scale than the EMPIR programme. Industrial and academic groups involved in measurement should play a more significant role in research programmes.
 - b) The “Knowledge triangle: research, innovation and education” should be considered as an innovative vision for the National Measurement System (NMS), creating collaboration between academia, industry and society.
 - c) Governance should include all the actors and stakeholders involved in measurement. Specifically, this should include NMIs, academia, research institutes, industry and relevant agencies at the national and European level.
- 3) Programme implementation should include:
 - a) The development of measurement science, including measurement-modelling issues, as required.
 - b) The contribution of measurement to economic, environmental and societal challenges.
 - c) Dedicated activities addressing measurement technologies beyond the state of the art to ensure European leadership in emerging areas.

⁵ This recommendation must be seen in the light of the strong increasing budgets for measurement in countries like China and India [IA 2013] and the USA which doubled the budget for their NMI over the last 10 years. [<http://www.sciencemag.org/news/2012/02/nist-14-budget-increase-would-measure-nicely>, <https://www.nist.gov/about-nist/our-organization/budget-planning>].

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GLOSSARY

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| BAAS | British Association for the Advancement of Science |
| BCR | Bureau Communautaire de Référence |
| BIPM | Bureau International des Poids et Mesures |
| CRM | Certified reference material |
| DI | Designated institutes |
| EMPIR | European Metrology Programme for Innovation and Research |
| EMRP | European Metrology Research Program |
| ERA | European Research Area |
| FP | Framework Programme, |
| JRC | Joint Research Centre |
| H2020 | Horizon 2020 |
| MERA | Metrology for the European Research Area” |
| MID | Measurement Instruments Directive |
| NEST | New and Emerging Science and Technology |
| NMIs | National Metrology Institutes |
| NMO | National Measurement Office |
| NMSs | National Measurement Systems |
| SI | International System of Units |
| SMT | Standards, Measurements and Testing |
| WFD | Water Framework Directive |

QUESTIONNAIRES

I. FACE-TO-FACE INTERVIEWS

II. EURAMET BOARD, EMRP-/EMPIR-MANAGEMENT:

1. Information

- 1.1. What does EMRP/EMPIR means to your organisation and country?
- 1.2. What are the differences between EMRP/EMPIR from your perspective?
- 1.3. Which other initiatives and actions where your organisation is involved affected EMRP/EMPIR?
- 1.4. How do you perceive, at present and in a perspective, the structure and the role of a National Measurement System (NMS)? In this regard, you may perhaps consider the following points:
 - 1.4.1. Do you know how the NMS is organised in your country and does it represent the necessary partners to cover the topic adequately
 - 1.4.2. In respect the EMRP/EMPIR Calls, did you experience any limitations to put consortia together, due to the requirements dictated by the call?
- 1.5. Do you think that the EMRP/EMPR programmes provide a sufficient support, at the European level, to research activities in the metrology/measurement area?

2. Assessment

- 2.1. How do you assess achieving the **objectives** of EMRPM/EMPIR?
- 2.2. To what extent are the **objectives** of the initiatives EMRP and EMPIR **still relevant**?
- 2.3. To what extent are initiatives EMRPM/EMPIR **appropriate** to support the **realisation of the EU policy objectives** such as:

ERA: More effective national research systems, Optimal transnational co-operation and competition, An open labour market for researchers, Gender equality and gender mainstreaming in research, Optimal circulation and transfer of scientific knowledge
http://ec.europa.eu/research/era/index_en.htm ,

Innovation Union: Innovation Union is the European Union strategy to create an innovation-friendly environment that makes it easier for great ideas to be turned into products and services that will bring our economy growth and jobs.
http://ec.europa.eu/research/innovation-union/index_en.cfm ,

the three "O": Open Innovation, Open Science, Open to the World according to the <https://ec.europa.eu/research/openvision/index.cfm>)?
- 2.4. How do you assess the **efficiency** of EMRPM/EMPIR referring
 - 2.4.1. implementation,
 - 2.4.2. governance and
 - 2.4.3. supervision?
- 2.5. How do you assess the **coherence** with other initiatives and actions (see 1.3), which are thematically related to EMRP and EMPIR?
- 2.6. Assess the EMPIR initiative **appropriateness** of the funding model with regard to the matching principle between Union and non-Union funds!
- 2.7. How do you manage the national funding (**indirect costs**) in correspondence with the European funding for your organisation?

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The metrology initiatives European Metrology Research Programme (EMRP) and European Metrology Programme for Innovation and Research (EMPIR) are public-public partnerships under article 185 of the Treaty on the Functioning of the European Union. EMRP launched calls from 2009 until 2013, and EMPIR is launching calls from 2014 until 2020. The final projects of EMRP are ending in 2017, while EMPIR has so far launched projects from the three first years of implementation.

This report was prepared by an independent expert group for the European Commission to serve as a part of the final evaluation of EMRP as well as the interim evaluation of EMPIR. The report provides a clear endorsement of the metrology initiatives. It supports the full continuation of EMPIR, and suggests increasing the budget for a potential successor initiative. The experts advocate increasing openness and inclusiveness to involve a wider measurement community, as well as ensuring effective coherence with other programmes.

Studies and reports



