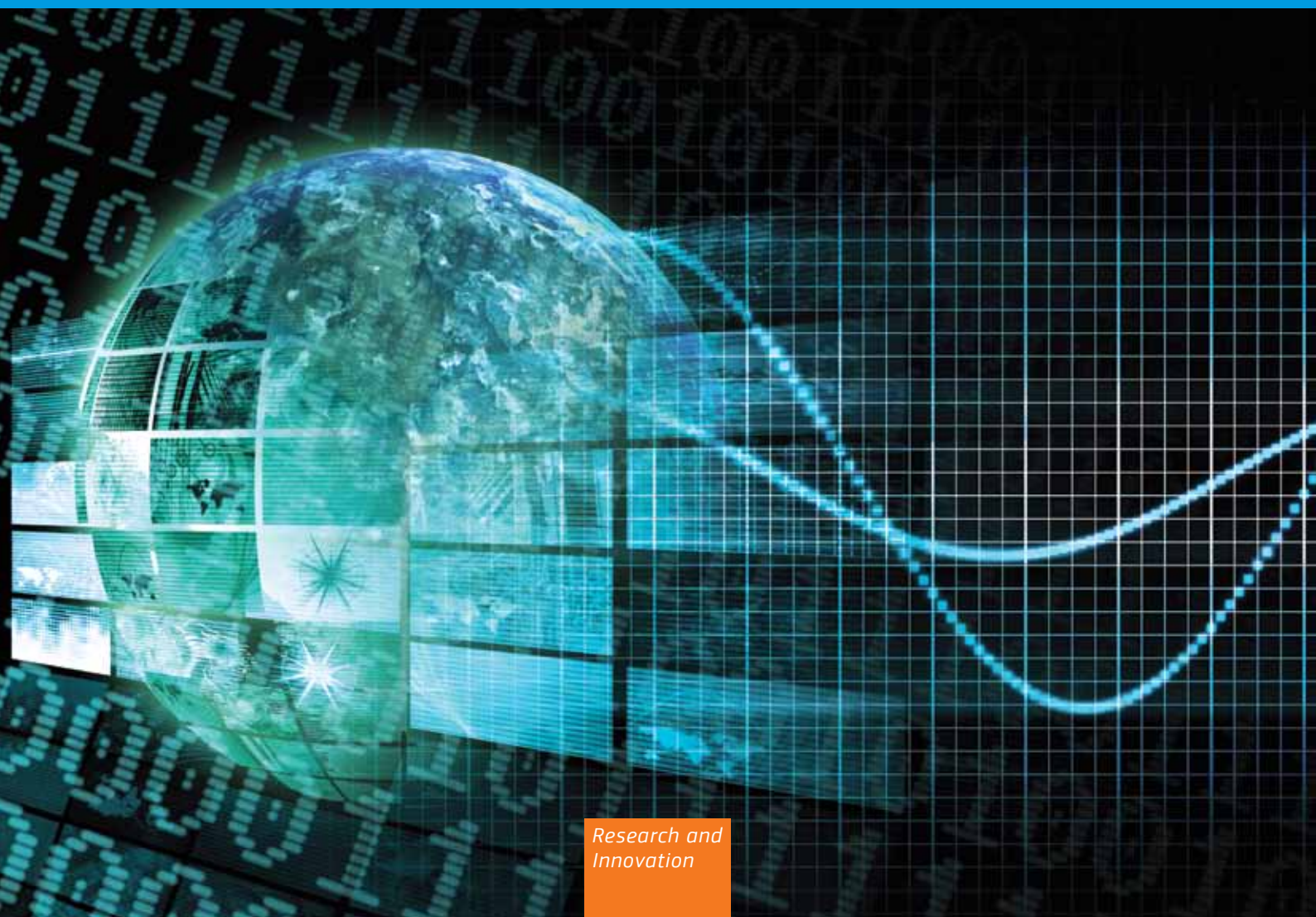




European
Commission

Interim Evaluation of the European Metrology Research Programme (EMRP)

Expert Panel Report



Research and
Innovation

EUROPEAN COMMISSION

Directorate-General for Research and Innovation
Directorate B – European Research Area
Unit B.4 – Joint Programming

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Interim Evaluation of the European Metrology Research Programme (EMRP)

Expert Panel Report

Evaluation Panel

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Robert Kaarls
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Cataloguing data can be found at the end of this publication.

Luxembourg: Publications Office of the European Union, 2012

ISBN 978-92-79-22681-6

doi 10.2777/58355

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Printed in Luxembourg
printed on elemental chlorine-free bleached paper (ecf)

Preface

When in 2000, in Lisbon, science and research were placed at the core of the development policies of the EU, it was clear that these were the key factors in promoting growth and competitiveness in Europe. The same Lisbon Summit endorsed the creation of a European Research Area (ERA), a proposal put forward by the Commissioner for Research, Antonio Ruberti, in the mid nineties which had remained “lettera morta” for some years and then was transformed into a political project that constituted an important pillar of the Lisbon Strategy.

ERA was meant to be the ‘single market’ for the most valuable goods we have: knowledge, the ‘fifth freedom’, to emphasize that the free movement of knowledge within the ERA would benefit the EU.

The ERA project has advanced too slowly over the years, perhaps due to weaker determination than that which was manifested in pursuit of the single market for all the other goods. New impetus was needed and rightly the European Council of February 2011 endorsed the objective of completing the ERA by 2014, in the frame of the new strategy, Europe 2020.

More and better investment in knowledge for growth, a contribution to the building of the ERA and attempts to address the grand challenges are the general objectives of the European Metrology Research Programme (EMRP).

The focus on the grand challenges (energy, environment, health...) and coordination and integration of metrology research programmes (an estimated 50% of the national investment is now influenced by the execution of the EMRP) are widely regarded as key success factors of the EMRP.

The EMRP, which is the object of this mid-term evaluation, is the third Article 169 (now Article 185 TFEU) initiative identified in the 7th Framework Programme. Though it is quite a new initiative in the EU research panorama and furthermore only the projects of two of the foreseen five calls have been selected, negotiated and are in the process of being carried out, the panel expresses an overall positive judgment and approval of the programme. The panel wants to stress, besides the above-mentioned adherence of the programme to the general goals of the EU strategy, the EMRP’s generally high quality of governance and management through transparent and effective process, the efficiency and effectiveness of coordination, the significant pooling of financial and human resources, the modernisation of the system also by focusing on new technologies and the increased profile of Europe as a global leader in the in metrological field.

There are rounds for improvement of the EMRP; let me notify in advance a couple of the recommendations that you will find in the report:

- The extension of the questions addressed by the grand challenges is an excellent opportunity to open up and strengthen the expertise of the National Metrology Institutes (NMIs) by close collaboration with academia and industries. The second part of the ERMP should open up to a much larger panel of industrial participants and to academia also to promote innovation in any technological or industrial field, so as to

foster consistency with the EU strategy for an Innovation Union. If the EU is left behind on innovation, it will also be left behind economically.

- Further and special attention must be dedicated to include and support new Member States and Candidates, often the less research-intensive NMIs, to build metrology research capacity. It seems that up to now the current model has not properly addressed the needs of the new and smaller developing countries and NMIs, risking the widening of the already existing gap between well-established and emerging NMIs. This would contravene the core orientation of EU to work towards the balanced sustainable development of Europe's regions. Economic and social cohesion is a concept introduced 25 years ago in the Single European Act and the Cohesion Policy has framed the Union's intervention by providing a strategic approach at EU, national, and regional level. Consistency of approach is a must which we cannot escape from. That would be a serious mistake.

Before concluding this brief foreword by thanking the panel, I'd like to express some reflections dedicated to a wider public, in particular to the people of the political and institutional world, to those who are in charge of devising policies for the benefit of citizens who may, like me in the past, have only a superficial knowledge of metrology and how important it is in shaping the quality of life

Very few of us know that the cost of weighing and measuring is around 6% of the European GNP, because metrology, the science of measurement, is almost unknown outside the metrology community. We need to increase awareness of metrology, a science at least 5000 years old, on which our everyday life depends. It is impossible to speak of almost any facts of life like shopping and feeding, health and work, science and trade, without referring to measures. In almost every act of life metrology is present; and it is not a matter of science or research, it is everyday life which is permeated by metrology. Metrology affects private and public life, economy, health, environment, personal and public security; metrology is essential to raise our quality of life.

I am saying this at the conclusion of this short foreword to draw attention to metrology, hoping to contribute to making this science more visible and to spreading awareness of its importance. We not only need to establish a common metrological frame of reference in Europe and between Europe and the other regions of the world; we need to diffuse information and raise awareness to a wider target audience, starting with those who decide policies at national and regional level. They can do a lot for metrology, and thus for improving the quality of people's lives.

Finally I want to congratulate and thank the members of the panel for their work and for their capacity to be a real team, able to carry on individual work, share it and reach collective results. A special thank you to the rapporteur, Angus Hunter, especially but not only for his patience when deadlines were not respected, and to Wolfgang Wittke from the European Commission, DG Research & Innovation, for his "light touch" in supporting and facilitating our work without interfering in our review of the Programme.

Pia Locatelli
Chairperson

Executive Summary

Metrology, the science of measurement, is as old as civilisation itself and is fundamental to commerce and regulations. It is also an essential tool for scientific research and technological innovation. The leading edge of metrology is the definition of internationally accepted units of measurement (metre, kilogram, second). This is linked by a traceability chain to the market in every country and underpins global trade and manufacturing in many sectors. The governance of this (largely invisible) chain involves a delegated network of technical centres, known as National Metrology Institutes (NMIs), which operate each country's metrology system on behalf of the relevant Ministry. The more research-intensive NMIs also play a leading role in advancing the state-of-the-art by developing and deploying new and more accurate methods of measurement using technologies that have emerged from the wider scientific community.

The core discipline of metrology, and the main focus of the NMIs, is therefore quality-assured measurement based mainly on the physical sciences ranging from basic units of length & mass to advanced photometry & radiometry. However, to address the grand challenges of the modern world we also need traceable, more accurate and comparable measurement methods in other fields such as biology and chemistry and to support the safe and economic exploitation of the new biotechnologies and nanotechnologies. These have more to do with tackling environmental pollution and health care issues like medical diagnostics, pathogens, toxic residues and nutritional content. This means that the science of measurement is now much more complex and interdisciplinary. Some national policy makers have responded by opening up the national measurement system to Designated Institutes (DIs) that have the competence and infrastructure to complement the work of the NMIs in specific areas. It also means that the quest for new, quality-assured measurement technologies, particularly to support new regulations and innovation, now extends beyond the traditional domains of both the NMIs and their governing Ministry.

The societal, technological and economic drivers to modernise the scientific metrology base, and enable it to have a much broader impact, was one of the main reasons for the European Metrology Research Programme (EMRP) that was conceived in 2007. It included three main actions:

- Pooling European excellence in metrology research,
- Opening the system to the best science, and
- Capacity building across the Metrology ERA especially in those NMIs with limited metrology research capacity

The relevant ministries in 22 countries collectively made a commitment to coordinate at least EUR 200 million of their dedicated NMI/DI funding within the EMRP for a seven year period, subject to a EUR 200 million co-funding contribution from FP7. The EU Parliament and Council formally decided on EMRP in summer 2009 and the EUR 400 million programme commenced. A dedicated implementation structure (EURAMET e.V.), involving all 37 NMIs in Europe, had been established in 2007 to manage the joint programme.

Evaluation of the EMRP

The Interim Evaluation of the EMRP was carried out from June to November 2011 by a Panel of experts with complementary experience of EU policy, metrology and the European Research Area. The interim findings, conclusions and recommendations (after two years implementation of the Article 185 EMRP) are summarised below:

The Panel firstly considered the quality & efficiency of the EMRP implementation, the financial contributions and the level of integration that has been achieved two years after the commencement of the programme.

Quality and efficiency of the implementation

The Panel was most impressed by the quality and efficiency of the governance and operational systems that had been established by EURAMET, the EMRP Committee and the operational management units in Germany and the UK. These are all in accordance with the General Agreement. Three annual Calls for Joint Research Projects and associated researcher grants have been launched and batches of projects have commenced in the thematic areas of energy, the environment and metrology for industry. The 2011 Call includes the thematic areas of health and new technologies as well as a topic on fundamental metrology related to the international system of units (SI). A main issue that has been highlighted is the accompanying bureaucracy that is inherent with such a sophisticated programme. At least part of the user criticism is related to lack of experience of complex European projects. However, the elaborate annual joint programming procedures, whilst extremely valuable in terms of structuring effects, represent a significant hidden cost for the NMIs.

Financial Contributions

The national commitment of at least EUR 200 million includes 10% in cash and the remainder as in-kind allocation of dedicated NMI/DI resources to EMRP projects. This is managed through a competitive bidding system with proposals evaluated by an independent panel of experts from outside the NMI/DI community. Two of the seven annual cash payments have been made and some EUR 60 million of in-kind resources have been committed to successful project consortia in response to the first two calls. Demand clearly exceeds the available budget as the value of submitted proposals has been around twice the funding for each Call. The main issue that has been highlighted is the significant gap in allocated budgets between the most research-intensive NMIs and the remainder. The budget differential is two orders of magnitude in scale between the largest contributor (Germany) and seven countries that are participating with a national budget of less than EUR 1 million. This is hardly supportive of the key action to build research capacity across the ERA. Some clearly would like to increase their budget with hindsight and the larger countries appear to be sympathetic to this option if a practical solution can be found. On a related matter, the Panel was disappointed to learn that the JRC/IRMM is allowed to take advantage of the FP7 co-funding without contributing to the common pot for management costs.

Integration of national metrology research programmes

The EMRP has enabled a step-change improvement in scientific integration between the NMI/DIs in participating countries, but the huge mismatch in scientific capacity and available national funding has limited the ability of the less research-intensive institutes to participate. The result is that the research capacity gap is widening. The big NMIs are taking full advantage of the EMRP but it has marginal benefits for those that are at the embryonic stage. Also, the level of integration with centres of excellence in the wider ERA is limited to those that can participate without EMRP co-funding and individual researchers that are able to take advantage of the grant schemes. This means the degree of integration with the wider research community is still marginal through the programme. In spite of this, a wide range of external stakeholders have contributed to the elaborate process of defining priorities for the annual Calls. Also, some of the well-established NMIs have connections with the wider research community through their national programmes and other parts of FP7.

The evidence of financial integration is clear as some 50% of dedicated national funding for metrology research is jointly 'programmed' through the central evaluation process using independent experts. The 'virtual common pot' works well because of the dedicated institutional funding commitments that are a feature of the metrology research community. The main issue is the large variations in budget commitments between the participating countries.

The priority for further integration is to find ways to help the weaker participants close the scientific/funding gap with the large NMIs and to broaden the level of scientific integration with the wider research community.

Progress towards the objectives of the EMRP

The Panel also considered how much progress had been made in the first two years in relation to the objectives of the EMRP.

General Policy Objectives

The EMRP has made substantial progress in relation to the 5th freedom (the free movement of knowledge within the ERA) as the joint research projects involve an average of eight countries. There is also evidence of participation in these projects by industry and academic researchers that are funded from their own resources. The partial focus on the grand challenges related to energy, environment and health is enabling more interdisciplinary collaboration within the metrology community and, to a limited extent, with the wider research community.

Specific Objectives

The structuring effect in relation to financial integration is clear and an estimated 50% of the dedicated national budgets for metrology research is now coordinated within the EMRP. There is also a useful structuring effect that is apparent through the elaborate annual process of setting priorities for the Joint Calls, in spite of the inherent bureaucracy, and this may also

be influencing national priorities in some countries. The structuring effect and defragmentation is clearly greater in those countries that have a relatively centralised metrology system. It is too early to assess the impact of these structuring effects on industry, society and the exploitation of new technologies but there is no doubt that a level of critical mass is being achieved that would have been impossible without the EMRP.

Metrology Research Objectives

The EMRP has nine specific metrology research objectives encompassing grand challenges, capacity building, open access to infrastructures, increasing collaboration with the wider scientific community, modernisation, mobility of young researchers, better coordination of international affairs, supporting regulation & standards and supporting industry and economic growth. All of these are influenced to some degree by the EMRP but progress on capacity building, mobility and collaboration with the best European scientists is still unsatisfactory. Also, it is clear that the scientific excellence objectives of the EMRP tend to foster more basic research activities and it is unclear how the gap between the research results and exploitation (i.e. industrial innovation, regulatory support, standardisation) will be achieved. This would be an important consideration for any future continuation of this excellent programme under Horizon 2020.

European Added Value

Added value of the Article 185 instrument

In considering the European added value of the EMRP, the Panel returned to the ex-ante impact assessment that compared the expected impact of the Article 185 with the two other options for a joint initiative in metrology – i.e. ERA-NET and a specific theme within FP7. With some minor shortcomings, the relative added value that has already been achieved for the 12 qualitative impact indicators demonstrates clear advantages of the Article 185 over the other two instruments. The main weakness of the Article 185, as expected, is that the interaction with the wider science community is not as great as it would have been with an open initiative within FP7. The Panel also considered the actual indicators of European added value and observed three main effects. Firstly, EMRP achieves critical mass by enabling NMIs and DIs from 22 countries to engage in joint research projects. Secondly, the EUR 400 million co-funded programme represent a large scale pooling of national and FP7 resources for metrology research. Last, but not least, the joint activities leading to thematic priorities for each annual Call (joint programming) is clearly having an integration effect and reducing unnecessary duplication of research activities.

Advancement of the Metrology ERA

The Panel had a common view that the Article 185 is an almost perfect instrument for joint programming within the metrology community due to the long term national funding commitments, the relatively homogenous national structures and the pre-existing networking frameworks. It could therefore be argued that the EMRP has certainly been successful in creating a Metrology ERA within the inner circle of NMIs (the Members of EURAMET) and also to some extent the DIs. However, the demand for traceable, more accurate and comparable measurement methods and tools means that more integration is

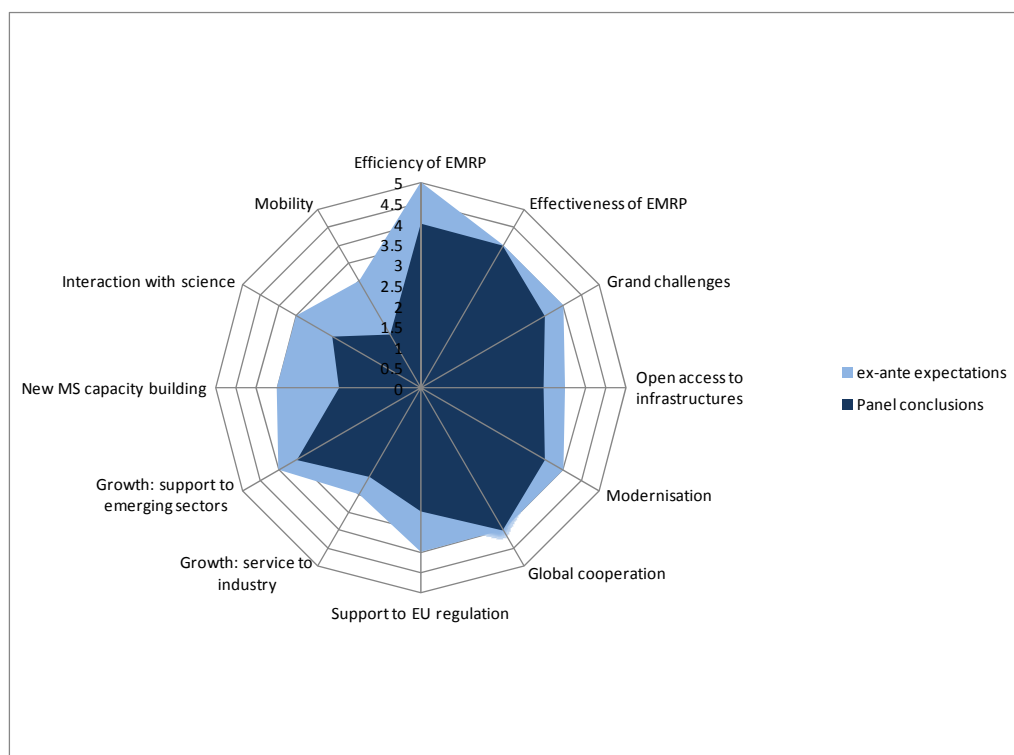
needed with the wider research community that is at the leading edge of the chemical, biochemical and microbiological sciences. This should be an important objective of any future programme.

Panel Conclusions

The overall opinion of the Panel is that the EMRP is a well managed joint European research programme that has already achieved a relatively high level of scientific, management and financial integration. After only two years of implementation it is too early to assess the quantitative impacts and so the Panel has concluded on four main questions: how well is the EMRP performing compared with the original expectations, how can it be improved, how can its impact be increased if there is a successor programme and what lessons have been learned for other Joint Programming Initiatives.

Qualitative Impact of the EMRP

The 12 point framework of the ex-ante impact assessment was also used by the Panel to structure its qualitative conclusions on the impact of the EMRP. This had two advantages. It allowed a direct comparison with the expectations and minimised the risk of appearing to be over-critical in areas where the potential impact was not expected to be so great.



Of course, this is quite a subjective assessment but it allowed the Panel to conclude that:

- The EMRP is performing well in relation to most of its original expectations

- There are significant gaps between expectation and reality in relation to three qualitative impact indicators: capacity building, interaction with the wider scientific community and mobility

Recommendations for the EMRP

The Panel has therefore made 20 recommendations. These include nine improvements that could increase the impact of the current Article 185 initiative, such as:

1. Harmonise further the management procedures and provide European research project management training for JRP coordinators and potential proposers
2. Establish a key performance indicator (KPI) for time-to-contract and set targets for improvement
3. Use expert facilitators to foster better inclusion of those countries with limited metrology research capacity with the aim of closing the gap with the more advanced countries
4. Explore the degree of flexibility that could be applied to the management of the mobility grants to overcome the relocation barrier
5. 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
6. Explore the potential added value of creating incentives to enable cross-fertilisation between complementary EMRP and FP7 actors and projects
7. Explore ways to better use the grant schemes to foster links with the best centres of excellence across Europe
8. Explore options for foresight workshops with regulatory ministries/agencies and the relevant Commission DGs
9. Increase the weighting of the impact criteria related to rapid exploitation within Europe

In addition, the Panel has proposed a further 11 recommendations that should be considered for the design of any future initiative and to enable EURAMET to reach for higher levels of European integration:

10. EURAMET database of metrology experts outside the NMI/DIs to support evaluation activities (the experience of the EUROSTARS Article 185 may be useful in this respect)
11. Twin track innovation and policy driven approach including separate instruments to enable both advancement of new knowledge and exploitation of existing knowledge.
12. Develop a more practical instrument to enable better access to the best centres of excellence in the wider research community and/or dilute the prioritisation criteria that is biased towards topics that best fit NMI competence.
13. Help developing NMIs and DIs to build scientific capacity that aligns with their national growth strategies through the use of both the EMRP and Structural Funds.
14. Foster Joint Research Projects that promote inclusion and development of embryonic centres of excellence consistent with European strategies

15. Develop a joint roadmap of European metrology infrastructure to 2020 including the development of truly European centres of excellence and mutual access agreements
16. New EURAMET committee structures and/or composition to institutionalise modernisation objectives and reinforce the commitment to working together on societal challenges
17. Explore options to exploit, or align with, the well known and successful FP Marie Curie instrument.
18. Develop consensus within EURAMET on formal coordination links between the EMRP and other leading metrology institutions worldwide
19. Dedicated EMRP Calls to support regulatory and/or standardisation roadmaps
20. Widely open foresight workshops to identify metrology-related barriers to the safe and rapid exploitation of new technologies

Recommendations for Future Joint Programmes

The EMRP is an excellent example of a joint programme aimed at creating critical mass to address complex, interdisciplinary social challenges and minimise duplication of research efforts. As an enabling technology sector, it is also clear that the metrology community has an important role to play in fostering a more open culture of innovation within the European Research Area. This is still work-in-progress but it must be remembered that there are only a few Article 185 initiatives. Thus, the model is still quite embryonic in terms of what can be achieved both within the instrument and also by using it as the platform for achievement of higher level ERA objectives.

Whilst the Panel acknowledges that the particular situation of NMIs and the associated funding landscape makes it an ideal candidate for the Article 185 instrument there are also some success factors and lessons that are more generic. The most important of these appears to be the long standing tradition of cooperation and stable level of dedicated funding for institutes that can partly integrate their scientific resources within a joint programme.

The Panel therefore concluded that there are six main criteria that should be fulfilled to assess the potential for a successful Article 185 initiative. These are:

- Scope for scientific, management and financial integration
- Common strategic research & innovation agenda of a significant scope and complementarity to the EU Framework Programme
- Strong involvement of programme owners, policy makers and both the scientific and business community
- Multi-annual financial commitments of significant size from participating countries
- Strong managerial structure and practical experience in programme implementation
- Solid rules of cooperation embedded in a legally binding governance model

It is the considered opinion of the Panel that the most critical factor for any potential Article 185 initiative will be related to Financial Integration. It is still a reality that there are major disparities between the scale and structure of national investments in R&D. Some countries

simply do not have the budgets or flexibility to participate effectively in joint research programmes. They need to be more strategic about their research priorities and/or focus more on innovation and technology transfer activities. It would seem to the Panel that the core-funded public research organisations including universities and other institutes have the strongest potential for establishing Article 185 initiatives as they are in the fortunate position of having a stable, non-competitive source of funding that could be coordinated at the European level.

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1. Introduction

1.1 Terms of Reference

The terms of reference for the Interim Evaluation stated that it shall:

1. Assess the progress towards the objectives of the EMRP.
2. Assess the level of financial contributions to the Programme by participating countries compared to initial commitments.
3. Assess the performance of EMRP as an integration of national metrology research programmes in the spirit of Article 169 of the EC Treaty (now Article 185 of the TFEU) and assess scientific, management and financial integration. In this context, the role of the European Commission should also be addressed.
4. Assess, with a focus on operations and results, the EMRP as an operational structure, taking into account the quality and the efficiency of the implementation. In this context, the role of the European Commission should also be addressed.
5. Assess the European added value of EMRP, using Article 185 TFEU, compared to other forms of support to R&D (via the Framework Programme, via ERA-NETs, via National & Regional programmes).
6. On the basis of this assessment what is the impact of EMRP and draw possible lessons to be learnt and recommendations for adjustments as appropriate for the current EMRP.
7. On the basis of this assessment, make recommendations for a possible continuation of EMRP (if applicable).
8. On the basis of lessons learnt on the case of EMRP, provide possible recommendations for future joint programmes involving Member States and the European Commission using Article 185.

The structure of the report has been designed around these requirements. It commences with an overview of the EMRP and then summarises the findings of the Panel with respect to the quality/efficiency of the implementation, financial contributions and the degree of integration that has been achieved. This is followed by an assessment of progress towards the objectives and European added value. The Panel then concludes on the impact of the EMRP so far and recommendations for both the current EMRP and any future initiative. It also makes some tentative recommendation for Future Joint Programming initiatives.

1.2 Evaluation Panel

The experts that were invited to serve on the Panel for the Interim Evaluation were carefully chosen to give an optimal mix of expertise, nationalities and gender. They are:

- Pia Locatelli (Chair): who was a Member of the European Parliament during the period of FP7 and EMRP adoption

- Olivier Donard: Research Director at the French CNRS and internationally recognised scientist in the field of analytical chemistry and metrology for industrial and environmental applications
- Robert Kaarls: a former Director of the National Metrology Institute of the Netherlands and current Secretary of the CIPM (International Committee for Weights and Measures)
- Jana Kolar: the Director General, Science and Technology Directorate at the Ministry of Higher Education, Science and Technology in Slovenia
- Angus Hunter (Rapporteur): an independent consultant with in-depth experience of management and evaluation of European Research Area policy studies and projects

The panel was therefore able to consider the EMRP from a variety of different perspectives.

1.3 Methodology

The evaluation was carried out from June to November 2011. It consisted of an iterative process of reviewing documentary evidence, stakeholder consultations and panel workshops that culminated in the final version of this report. The key milestones were:

- First meeting of the Panel on 20th June 2011
- Consultations with senior representatives of Euramet e.V. and the EMRP management team
- Triangular consultations with stakeholders in the national metrology institutes, national ministries and the wider scientific community
- Second meeting of the Panel on 1st and 2nd September
- Preparation of a Discussion Document with interim conclusions from the evaluation
- Key Issues workshop with senior representatives of Euramet e.V. and the EMRP management team on 20th September
- Third meeting of the Panel on 21st September
- Preparation of 1st draft of the Panel Report
- Fourth meeting of the Panel on 24th October
- Preparation of the final draft of the Panel Report
- Final meeting of the Panel on 29th November 2011

2. Overview of the EMRP

2.1 Background

The evolution of Metrology

The roots of metrology, the science of measurement, date back to the beginning of social structures as 'doings and dealings' that require compatible units of measurement and standards. Progress in science and technology not only required the development of uniform standards for measurements of ever increasing accuracy in many new technical fields, but also became indispensable for linking all physical units. The origins of metrology research are therefore underpinned by the physical sciences and the basic units of measurement such as time, length, mass, light, electricity, etc. These are maintained and improved through national and international harmonisation networks leading to common measurement standards and calibration services for industry, commerce and public services. In Europe, the measurement standards are maintained in each country by the National Metrology Institutes (NMI). Some are involved in the development of primary standards (scientific metrology), others provide the traceable link between the primary standards and the calibration of measurement instruments (legal metrology).

Metrology is therefore a key driver of economic development despite the fact that it is almost invisible to the general public. Its direct positive economic impact has long been recognised in most developed and developing countries. It is also important to international trade. For example, in 1990, the US semiconductor industry invested more than \$650 million in metrology alone. In 1996, this investment jumped to about \$2.4 billion and to \$ 5.5 billion by 2001. In the UK, the impact of metrology on the economy has been estimated at 2% of GDP¹.

But the science of measurement is no longer just limited to physics. Increasingly, it is also relevant to the technical challenges of the new technology industries (e.g. biotechnology, nanotechnology) and societal challenges such as health, security, environment or climate change. For these, the issues are more interdisciplinary and related to the chemical, biochemical or microbiological sciences. It is thus a key enabling technology. This raises a whole new set of measurement questions and, whilst some of the NMIs have diversified into the chemical and biological sciences, the main centres of excellence are found in the wider scientific community. Some of these have achieved the status of National Designated Institutes (DI)² and their numbers are now much greater than the NMIs.

The hierarchy of modern metrology activities from the primary measurement standards to the application of knowledge for the benefit of industry and society is shown in Figure 1.

¹ Temple, P; Williams G. Infra-technology and economic performance: evidence from the U.K. measurement infrastructure. *Information Economics and Policy*, 14 (2002) 435-452

² Specialist institutes responsible for certain national standards and associated services that are not covered by the activities of the National Metrology Institutes.

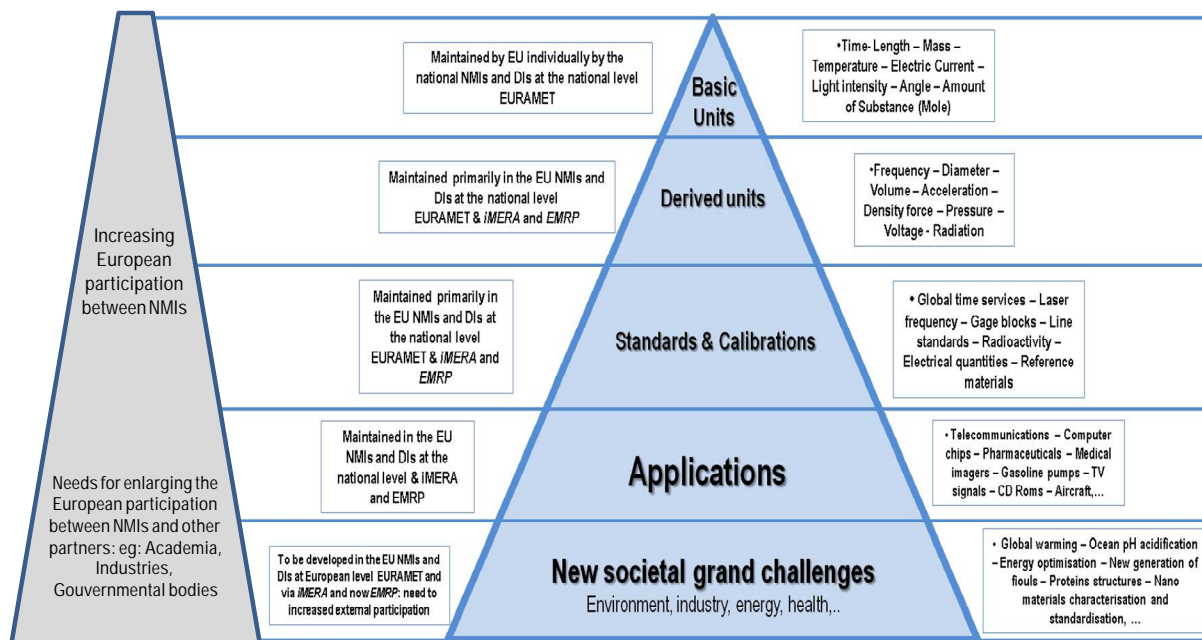


Figure 1: Hierarchy of Metrology

This shows the hierarchical metrology chain from the basic physical units, via primary standards and calibration methods, to the applications in industry and commerce. It also highlights the need for a more open and inclusive approach to scientific metrology with stakeholders from the NMIs, DIs, the wider scientific community and government bodies that are concerned with societal regulations and standards. All of these can now be considered as stakeholders of the European Metrology Research Area.

The evolution of the European Metrology Research Area

The European NMIs have a long tradition of bilateral cooperation in scientific metrology and in 1987 they established EUROMET, the first pan European cooperation on measurement standards. The membership gradually expanded until it encompassed over 30 countries plus the JRC (represented by IRMM³).

During the 5th EU Framework Programme for RTD (1998-2002) the European metrology community was able to take advantage of a specific topic on 'standards, measurement and testing (SMT)' for collaborative R&D projects. This programme also co-funded a study by EUROMET on 'Metrology for the European Research Area (MERA)' that was completed in 2004 and looked at the options for closer cooperation between the NMIs in Europe.

The introduction of the new ERA-NET Coordination Action instrument in FP6 offered the opportunity to implement the MERA conclusions and iMERA was launched in April 2005. This

³ The Institute for Reference Materials and Measurements (IRMM) is one of the seven institutes of the Joint Research Centre (JRC), a Directorate-General of the European Commission (EC). Its mission is to promote a common and reliable European measurement system in support of EU policies

three year ERA-NET involved 14 NMIs, the JRC/IRMM and some national Ministries. The overall aim was to prepare for an ongoing programme of metrology research to be undertaken by the NMIs from 2007 onwards utilising Article 169 of the EU Treaty (now Article 185 TFEU). The main outcomes were a single legal structure (EURAMET e.V.⁴) and an Outline for a proposed European Metrology Research Programme (Ref 1).

The EMRP was one of four initiatives identified in FP7. As a bridging measure towards the Article 185 initiative an ERA-NET Plus proposal (iMERA Plus) was submitted in 2007 by EURAMET. This was supported by 21 countries, the JRC/IRMM and a €21 million co-funding contribution from the Community. The result of the single call was 21 research projects that were funded in 2008 with a total value of €64 million. Most of these are now completed and some case studies have been produced⁵.

The preparation for the proposed European Metrology Research Programme (EMRP) as an Article 185 initiative also started in 2007 and was further developed in parallel with implementation of iMERA Plus. It was adopted by the Commission in December 2008 and the Decision (Ref 2) by Parliament and Council was published in the Official Journal in September 2009. The external audit unit of DG RTD also carried out an ex-ante assessment of EURAMET and made a number of recommendations (Ref 3). EURAMET produced a tabular Action Plan (Ref 4) to address the recommendations and this was accepted by the external audit unit in September 2009. The General Agreement (Ref 5) was signed with the Commission in December 2009 and covers the period from May 2009 (start of the 1st Call for joint research projects) to the end of 2017.

Annual Implementation Plans have been prepared for 2010 (Ref 6) and 2011 (Ref 7). Annual Reports have been prepared for 2009 (Ref 8) and 2010 (Ref 9) as well as the EMRP Interim Report of June 2011 (Ref 10).

⁴ Throughout the report the term EURAMET is used as shorthand for the legal entity EURAMET e.V.

⁵ Interim Report (Ref 10)

2.2 Aims & Objectives

The Decision (No 912/2009/EC) of 16th September 2009 states that:

“The EMRP aims to support scientific development and innovation by providing the necessary legal and organisational framework for large-scale European cooperation between Member States on metrology research in any technological or industrial field.”

It further states that:

“The objectives of the EMRP are 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

These objectives were to be achieved through three main actions:

- Pooling excellence in metrology research – by creating competitive joint research projects, marshalling the capability of a sufficient critical mass from the networks of NMI and DI from the participating States to tackle major metrology challenges faced at European level
- Opening of the system to the best science – by increasing participation from the wider European research community through researcher grants
- Capacity building – by increasing the capability of the European metrology researcher community through researcher mobility grants targeting those EURAMET Member Countries with limited metrology research capability

2.3 Structure and Activities

2.3.1 Structure

Two of the conditions of the EU financial contribution were related to the structure of the EMRP, namely:

- The formal establishment of a dedicated implementation structure with legal responsibility, which shall be responsible for the implementation of the EMRP and for receiving, allocating and monitoring the Union financial contribution
- The establishment of an appropriate and efficient governance model for the EMRP

The Decision stated that the dedicated implementation structure was to be EURAMET e.V. (established in 2007 under German law). It also stated that the following bodies and internal structures would assume roles in the implementation of the EMRP.

- The EMRP Chair and deputy who would both be elected by the EMRP Committee
- The EMRP Committee, composed of NMIs whose countries are participating States
- The Research Council, composed of a balanced contingent of high level experts drawn from industry, research and academia and from international stakeholder organisations
- The Secretariat, composed of persons employed by, or seconded to, EURAMET e.V.
- The EMRP Programme Manager employed by EURAMET e.V.

2.3.2 Activities

The core activity of the EMRP is the funding of multi-partner, transnational projects addressing research, technological development, training and dissemination activities (EMRP projects). In view of the concentrated capacities in metrology, and the nature of national funding, the core part of the EMRP projects is executed by the NMIs and DIs. These EMRP projects are generally known as Joint Research Projects (JRPs).

In addition, in order to increase and diversify capacities in metrology, three grants schemes were to be set up:

- Researcher Excellence Grants (REGs) – to allow the participation of organisations from the wider research community in the EU Member States and countries associated with FP7. Each of these need to be associated with a Joint Research Project
- Researcher Mobility Grants (RMGs) – to develop the capacities of individuals in NMIs, DIs, EURAMET Member Countries not participating in the EMRP and other researchers benefiting from researcher excellence grants
- Early-Stage Researcher Mobility Grants (ESRMGs) – to prepare the next generation of experienced metrology researchers in the NMIs and DIs of participating States

The EMRP budget was planned to be distributed through five annual Calls for Joint Research Projects in the period from 2009 to 2013. The topics and expected outcomes are shown in Figure 2.

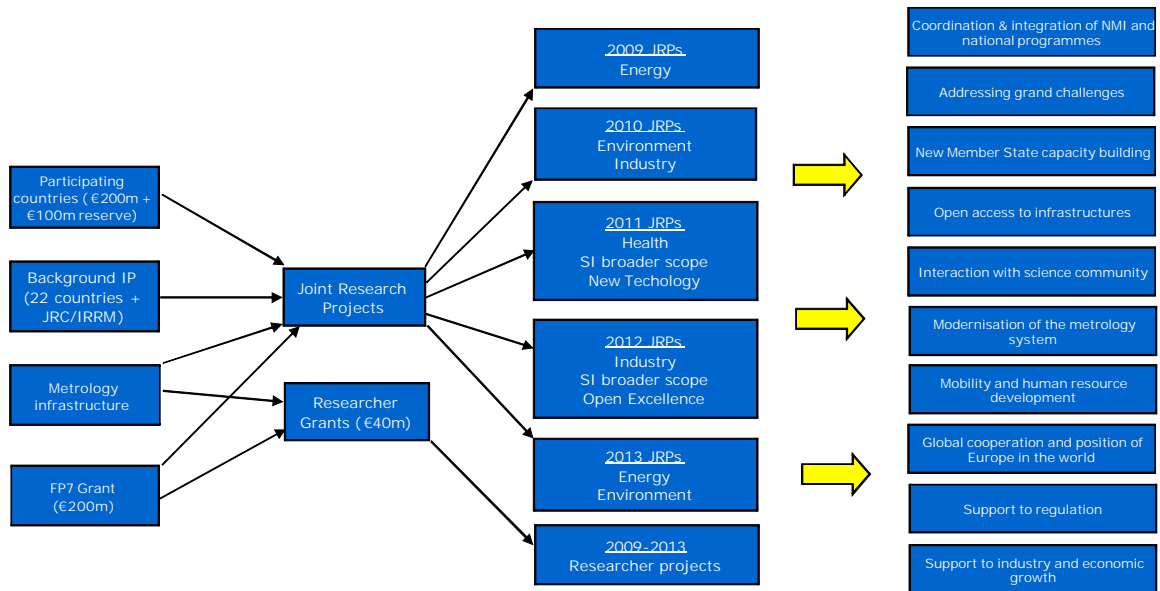


Figure 2: Expected EMRP Outputs and Outcomes

It was foreseen that the selection of EMRP projects and the award of REGs and RMGs would be implemented through a three stage process:

- Stage 1 – Call for potential research topics (PRTs) for EMRP projects
- Stage 2 – Call for proposals for JRPs (with the option for an associated researcher excellence grant)
- Stage 3 – Call to the wider research community to join EMRP projects through REGs and RMGs. These are launched in parallel with the publication of the list of selected JRPs from Stage 2

The call for Early Stage Researcher Mobility Grants is continuously open.

2.4 Funding and Financial Integration

The EMRP is co-funded from two main sources for a period of seven years:

- In kind and cash contributions from 19 EU Members States and three Associated States valued at a minimum of EUR 200 million plus a reserve funding capacity of EUR 100 million
- A Union financial contribution matching that of the participating States up to EUR 200 million

The aggregated cash contributions from the participating States were set at EUR 20 million to cover the running costs (EUR 16 million) and provide a 10% contribution (EUR 4 million) towards the researcher grants (EUR 40 million total budget). The contribution to the running costs is a binding ceiling.

The participating countries are Austria, Belgium, the Czech Republic, Denmark, Germany, Estonia, Finland, France, Italy, Hungary, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom, as well as Norway, Switzerland and Turkey. In addition, the JRC is eligible to participate.

The proposed allocation of funding to the joint research activities are shown in Figure 3, which gives the breakdown for each of the five annual calls and by type of activity. The high level themes for the targeted programme were defined during the iMERA Plus project (Ref 1).

Year	Targeted Programme	Indicative JRP budget (€m)	Indicative Grant budget (€m)	Total (€m)
2009	Energy	29.24	3.4	32.64
2010	Environment	38.38	4.46	42.84
	Metrology for Industry	44.18	5.14	49.32
2011	Health	30	3.49	33.49
	SI broader scope	21	2.44	23.44
	New Technologies	26.4	3.07	29.47
2012	Metrology for Industry	34.4	4	38.4
	SI broader scope	34.4	4	38.4
	Open Excellence	8.6	1	9.6
2013	Energy	47.3	5.5	52.8
	Environment	30.1	3.5	33.6
		344	40	384

Figure 3: EMRP Thematic Budgets

The expected distribution of researcher grants was EUR 30 million for researcher excellence grants, EUR 6 million for researcher mobility grants and EUR 4 million for early-stage researcher mobility grants.

Financial integration was to be achieved through the evaluation of proposals, which should be performed by independent experts under the responsibility of the dedicated implementation structure. The ranking by the independent experts should be approved by the dedicated implementation structure and be binding as regards the allocation of funding from the EU financial contribution and the pre-committed national budgets for EMRP projects. The core evaluation criteria must be, *mutatis mutandis*, those of the Rules for Participation in the Seventh Framework Programme for the EMRP projects and researcher grant schemes respectively. Thus the FP7 rules related to the evaluation criteria should be explicit in the calls for proposals.

Financial integration implies that the participating States effectively commit to contribute to the financing of the EMRP by providing national funding to all eligible participants in selected EMRP projects (from the national earmarked EMRP budgets), by providing a 'cash' contribution to a common pot to fund researcher excellence and mobility grants and fully funding the running costs of the EMRP. If necessary this may draw on the reserve funding capability amounting to 50 % of such budgets. A further element of financial integration is the unified approach towards eligible costs, based on the rules of the Seventh Framework Programme.

3. Evaluation of the EMRP

3.1 Quality and Efficiency of the Implementation

3.1.1 Activities

Implementation - management, evaluation and selection procedures

The EMRP is in its 3rd cycle of five planned annual Calls. These commenced in 2009 and the timing of activities (up to the 2011 Stage 2 Call) is shown in Figure 4.

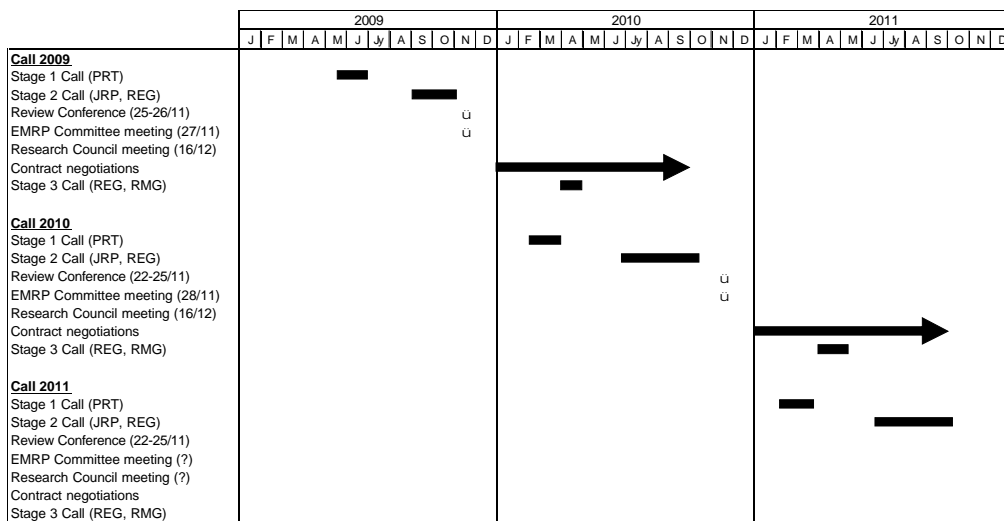


Figure 4: EMRP Annual Cycles

The cycle actually starts well in advance of the Stage 1 Call with the appointment of a Guardian for each Targeted Programme that will be included (e.g. energy, new technologies, SI). This appointment is made by the EMRP Committee with the objective of defining the Scope of the Stage1 Call. This person is responsible for stakeholder consultation and preparation of the 'Scope document' for approval by the EMRP Committee. The final versions are quite brief (one or two pages) but sufficient to highlight the areas of the subject that are within the scope of the Call. As the programme has matured these documents have become less prescriptive and are being prepared well in advance of the Call.

Stage 1 of the Call, for Potential Research Topics (PRTs), is launched and anyone (from anywhere) can submit a topic. This initially led to a bombardment of multiple PRTs from related stakeholders but the rules have since been refined to ensure that PRTs now include all supporting stakeholders. The quality of PRTs has therefore improved and these are typically quite well developed outline specifications of research needs. They are clustered and synthesised into a shortlist of prescriptive Strategic Research Topics (SRTs) by a sub-group of the EMRP Committee. It should be noted that the prioritisation is biased towards a requirement "that relevant expertise and facilities exist within EURAMET to address those

needs". This shortlisting criteria is clearly in conflict with opening up the EMRP to the best science in Europe.

Once approved by the full Committee, the Stage 2 Call is launched for Joint Research Projects (JRPs) and associated Researcher Excellence Grants (REGs) in response to the shortlisted topics.

The evaluation and selection of Stage 2 proposals for both JRPs and REGs is carried out during a Review Conference lasting so far between two days or a week (depending on the call volume), involving both referees and coordinators of JRP proposals. The referees are selected from the FP7 registration list but exclude anyone from the NMIs or DIs. The recruitment of referees with sufficient expert knowledge in metrology to assess the research proposals has thus proved to be challenging.

Unusually, compared with the situation for FP7, the referees have the opportunity to discuss proposals with the bid coordinators both informally and formally. During the review conference an Independent Observer and a Commission representative are present and follow the review conference so the process is very transparent. The Review Conference concludes with a single ranked list of proposals (recommended priority order for funding). The final decision on which projects are to be funded is taken at the subsequent EMRP Committee meeting. So far, the Committee has accepted the recommendations of the independent evaluation and the final selection is made on available budget for the call. The decision is endorsed by the Research Council, based on the report of the Independent Observer, including recommendations for improvement of the policy and procedures for future calls.

Efficiency and adequacy of the Call procedures

The Call procedures and document templates are quite elaborate and sophisticated. They are designed both to achieve the objectives of the programme and to be consistent with FP7 rules. Documented feedback from users (EMRP Interim Report) and stakeholder consultations suggests that the procedures/templates are rather bureaucratic and there is a strong desire for simplification. The Programme Manager believes that high professional standards of project planning and management are desirable in such a flagship programme.

Respect for main principles in the Decision

Conditions in the Decision made in 2009 by the Council and European Parliament include EMRP efficiently established, dedicated implementation structure, appropriate/efficient governance model, efficient performance of activities, financial commitments, compliance with State Aid rules, high level of scientific excellence and provisions governing IPR. It is clear that all of these principles are fully respected.

Timing of evaluation and selection processes

As shown in Figure 4 above, the evaluation and selection of proposals takes place within two months of the Stage 2 submission deadline. The process appears to be extremely well organised with the EMRP Committee meeting being scheduled immediately after the Review Conference. This means that the selection decisions are both confirmed and communicated before the end of each calendar year.

IPR provisions

Article 2 of the Decision states that the Community financial contribution shall be conditional on, amongst other things, the formulation of provisions governing the intellectual property rights arising from the activities carried out under the EMRP. The Decision also states that these provisions must follow the model used in FP7. The evidence that this is the case can be found in Clause 14 of the EURAMET Contract for Joint Research Projects (2010 Annual Report, Annex 16).

Survey feedback from JRP coordinators (Interim Report, section 5.4.5) suggests that IPR protection is a relatively low priority. This is partly related to the inherent orientation of NMIs towards open standards but may also be an indication that the EMRP is too biased towards basic research and/or that the researchers have a low commitment to further industrial or commercial exploitation.

Post-evaluation processes (contract negotiations, funding)

The first step, after the selection process, is that two project officers from the EMRP Management Support Unit (MSU) meet each project coordinator at their home Institute. The objective is to discuss what is required to convert the Stage 2 proposal (JRP-Protocol document) into the Annex 1 of the JRP Contract and to finalise the project budget. The contract negotiations are normally expected to be concluded in the first few months of the calendar year following the Review Conference but it is clear that this is a comparatively slow process that can extend beyond the summer. There seems to be several reasons for this long 'time-to-contract' period including programme management resource conflicts and a lack of urgency from project teams. The resource conflicts are mainly in the April to June period when the next Stage 2 Call is being prepared (see Figure 4 above). The project consortia seem content to delay the project start until the end of the summer, especially if there is an accompanying REG. NMI senior managers are keen to reduce the lead time for project cash flow reasons as payment of the pre-financing happens after the JRP contract document and consortium agreement is signed.

3.1.2 Management

EURAMET implementation and management

EURAMET e.V. was established as a legal entity in 2007 and was thus in a position to sign the General Agreement with the Commission in 2009. The EMRP has been fully integrated within the management structure of EURAMET with dedicated staff (independent from any NMI) and its own governance systems.

Effectiveness of EURAMET so far

There is no question that the EMRP is anything other than an extremely well organised programme that is achieving the main objective in the Decision (pooling excellence in metrology research). Consultation feedback suggests that EURAMET has been less successful with respect to the other two objectives (i.e. capacity building and opening of the EMRP to the best science in the wider research community). All of the governance and management structures are in place and it is expected that the five outstanding recommendations in the ex-ante assessment (Ref 3) will be completed by the end of 2011 (Ref 9, Annex 7). Three annual Calls have been launched and 35 JRPs and 38 Grant applicants have been selected from the first three thematic Calls (energy, environment, industry). This does not include Stage 3 Grants from the 2010 Call. There is evidence of continuous process improvement based on lessons learned in the initial calls and it seems that the NMI community has been able to overcome national policy differences in favour of the common benefits of the programme.

Distribution of tasks

There are clear and elaborate governance and executive structures. The main executive functions (head of secretariat, finance officer and programme manager) are now carried out by highly qualified senior managers that were legally separated from their former host institutes in 2010 to avoid any conflict of interest. There is also a Quality Manager within the EMRP management structure who reports annually on progress against the recommendations in the Ex-Ante Action Plan (Ref 4).

Sustainability of the EMRP

EURAMET is demonstrating excellence in governance/management of the Article 185 and envisages a successor programme with a more integrated approach to research and innovation. An outline for the proposed follow on programme (EMPIR: European Metrology Programme for Innovation and Research) has been prepared with the hope that it can be included in considerations for the new EU Horizon 2020 framework programme. At present, the benefits of the co-funding outweigh the 'hidden national costs' of the three stage Call system and administration of projects.

3.1.3 Governance

Governance structure

The following five bodies and internal structures have been implemented:

1. The Chair of the EMRP is one of the two Vice-Chairpersons of EURAMET
2. The EMRP Committee consists of one representative from each participating EURAMET Member
3. The Research Council currently has 16 institutional and personal members
4. The Secretariat consists of 15 individuals that are located at Braunschweig in Germany and Teddington in the UK. The Head of Secretariat is Dr. Wolfgang Schmid who is now

- legally employed by EURAMET e.V. rather than PTB. He is supported by the EMRP Programme Manager, the Quality Manager, a Legal Advisor and several support units
5. The EMRP Programme Manager is Dr Duncan Jarvis, who (like the Head of Secretariat) is now legally employed by EURAMET e.V. rather than NPL

EURAMET has demonstrated that it is a professionally managed organisation that can be trusted with the delegated powers of an Article 185 Contract. The evidence for this can be seen in the financial commitments that have been made by participating countries and the operational processes that have been implemented and refined through three cycles of joint programming.

Role of the Commission

EURAMET, and within it the EMRP Committee, appears to be playing an effective governance role in managing the programme in support of its objectives and is complying with the conditions that were set in the Decision, the General Agreement and the Ex-Ante Action Plan. The annual and interim reports are very comprehensive, open and honest about progress against the objectives. There is no reason why the Commission needs to intervene as the metrology community is clearly demonstrating self-governance and that it can be trusted with the delegated functions. The EMRP programme manager would like to see more strategic input from the Commission inter-service group during the process of defining the 'Scope documents' for each Call. A similar issue (related to the lack of integration of the EMRP with grand challenge policy makers) has been identified at national level (see Section 3.3.1 below).

3.1.4 Visibility

Activities ensuring visibility of the EMRP

The EMRP is clearly highly visible within the NMI/DI community, which is the primary target group for the programme. The website is the most obvious communication channel and it is apparent that the programme has also been promoted at broader European conferences such as the Innovation Summit and Industrial Technology Conference that were both held in 2010. However, there is no evidence from the Panel's consultation that the wider research and societal community is aware of the activities of the EMRP as it is perceived to be a rather closed programme.

The Implementation Plan for 2011 states that "EURAMET has an established public relations strategy to increase awareness of metrology and involvement in the EMRP" and newsletters are planned. The engagement with the European standardisation community has been strengthened through participation in the Research Council but the links with the European Technology Platforms seem a little weak (EURAMET "writes" to each of the relevant Technology Platforms ahead of each call to encourage their engagement). It could be that the most intense engagement with stakeholders takes place after the Stage 1 Call when the Proposed Research Topics are being formulated.

3.1.5 Access to the EMRP

Accessibility of the EMRP for non-NMI's

The EMRP Programme Manager provided the following statistics in relation to non-NMIs⁶:

- 65 research organisations (not being NMI or DI) are involved in EMRP projects
- 40 REG researchers, 67 unfunded partners and 38 research institutions are participating in the EMRP
- 3 unfunded partners from outside EURAMET countries are participating

The main barrier to wider access is the consolidated nature of national funding structures for metrology research, particularly in the larger countries, which is associated with national measurement infrastructures that support industrial production and regulations. This enables the publicly funded scientific resources in NMIs and DIs to be selectively assigned to specific JRP's (i.e. in kind contributions) but is unrealistic for opening to the wider research community (except for those that can participate without funding). It might be logical to consider options to enable coordination with complementary national and/or FP7 projects in the future rather than distort the core EMRP model.

Simplicity of application procedures

The EU co-funding and associated FP7 rules have made it inevitable that the application procedures will look and feel like those of FP7. The general view of the metrology community is that the EMRP application procedures are quite bureaucratic and are a major barrier to the capacity building objectives of the EMRP.

Communication of results including reasons for failure

The report of the Independent Observer for the 2010 Call indicates that the referees provide formal evaluation comments for feedback to the applicants. This appears similar to FP7 and is helpful for negotiations with successful applications as well as providing formal feedback to those who have been unsuccessful.

User friendliness of the EMRP

Although the EMRP has a delegated governance/management structure it is co-funded by FP7 and therefore the users express the same issues about bureaucracy and need for more simplification. Those who have practical experience of the intensely competitive FP7, and its predecessors, appreciate the relatively closed nature of the EMRP and the much higher probability of success (typically 50%). Those who do not, and the less research-intensive NMIs, find it to be extremely complex and much less user friendly than national programmes. Most of the national funding structures for the NMIs appear to be less formal, competitive and prescriptive. A key issue is whether the complexity is made worse than necessary because of the EURAMET governance/management system and/or the specific rules of the Article 185 and the degree to which the level of bureaucracy could be reduced in the future. What is clear is that the metrology community is making a huge resource investment in the preparation and proposal stages of each Call and this is a hidden additional cost for the participating countries.

⁶ Letter to Dr Wittke, dated 24th June 2011

3.2 Financial Contributions

Financial contribution by the participating countries

The collective financial commitment from participating countries to the EMRP was €200 million with a guaranteed reserve funding capacity of €100 million. Of the core commitment, 10% (€20 million) was to be paid in cash in seven equal instalments regardless of national success in the Calls. The first instalment was paid on 31st January 2010.

The in kind financial contributions are more complex and the 50% co-funding balance is distorted by the participation of the JRC, which does not apparently make a pro rata contribution to the common pot for central management systems and researcher grants. These contributions will be committed through five annual calls up to 2013 but, of course, will continue for several years thereafter until the projects are completed. The national budgets, annual cash payments and in kind commitments for the 2009 call (actual) and 2010 call (expected) are detailed in Figure 5.

	EMRP Budget (€m)		Cash Actual (€m)		Actual in kind per Call (€m)			
	Cash	In kind	Jan-10	Jan-11	2009	% in kind	2010	% in kind
Germany	7.154	64.386	1.022	1.022	3.765	5.8	17.357	27.0
UK	4.487	40.383	0.641	0.641	3.555	8.8	7.939	19.7
France	1.904	17.136	0.272	0.272	1.444	8.4	5.069	29.6
Italy	1.407	12.663	0.201	0.201	0.898	7.1	3.635	28.7
Netherlands	1.085	9.765	0.155	0.155	2.103	21.5	2.416	24.7
Finland	0.805	7.245	0.115	0.115	0.636	8.8	2.041	28.2
Switzerland	0.644	5.796	0.092	0.092	0.319	5.5	1.978	34.1
Spain	0.448	4.032	0.064	0.064	0.420	10.4	0.862	21.4
Czech Republic	0.427	3.843	0.061	0.061	0.312	8.1	1.103	28.7
Slovakia	0.252	2.268	0.036	0.036	0.135	6.0	0.507	22.4
Sweden	0.238	2.142	0.034	0.034	1.167	54.5	0.341	15.9
Denmark	0.224	2.016	0.032	0.032	0.325	16.1	0.363	18.0
Turkey	0.161	1.449	0.023	0.023	0.119	8.2	0.27	18.6
Norway	0.14	1.26	0.020	0.020	0.140	11.1	0.096	7.6
Slovenia	0.126	1.134	0.018	0.018	0.145	12.8	0.39	34.4
Austria	0.084	0.756	0.012	0.012	0.073	9.6	0.084	11.1
Belgium	0.084	0.756	0.012	0.012	0.029	3.9	0.092	12.2
Portugal	0.084	0.756	0.012	0.012	0.010	1.3	0.153	20.2
Romania	0.084	0.756	0.012	0.012	0.043	5.7	0.056	7.4
Hungary	0.084	0.756	0.012	0.012	0.080	10.6	0.311	41.1
Estonia	0.042	0.378	0.006	0.006	0.025	6.6	0.071	18.8
Poland	0.042	0.378	0.006	0.006	0.000	0.0	0.161	42.6
Total national	20	180	2.858	2.858	15.743		45.295	
JRC	0	0	0	0	0.467		1.559	
Total	20	180	2.858	2.858	16.210		46.854	

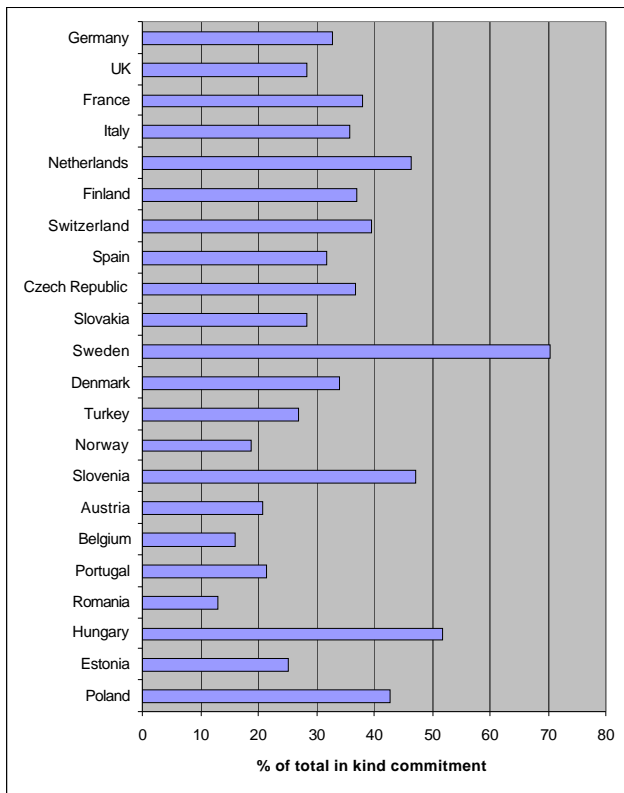
Figure 5: National Contributions

This shows that over €60 million of in kind resource has already been committed following the first two calls (approximately one third of the in kind budget). The 2009 call had only one targeted programme (energy). The 2010 and subsequent calls all have at least two targeted programmes. It therefore seems unlikely that the €180 million in kind budget will be

sufficient to satisfy demand from a total of 11 thematic calls areas that are planned over the period of the EMRP.

What is also very apparent in Figure 5 are the huge disparities in budgets across the 22 participating countries. Germany and the UK together account for more than 60% of the in-kind budget and seven countries have committed less than €1 million to a [€400 million] multi-annual international research programme. Countries like Sweden and Austria that are relatively research-intense and open to transnational programmes have a surprisingly low budget. Documented survey feedback and consultations suggest that those with smaller budgets would like to increase their commitment and participation.

The complexity of the financial model is further compounded by variations in national success in the annual calls. Figure 5 above highlights the percentage of the in kind budget that has already been committed by each country in the first two calls. The cumulative % in kind commitments for each country is highlighted in Figure 6.



This shows that some countries (Sweden and Hungary) have already committed more than 50% of their core in kind budget, whilst others have committed less than 20% (Norway, Belgium and Romania). This is an indication of relative national success in the initial calls and, in the case of Sweden, a deliberate policy to selectively focus on energy-related R&D (single topic for the 2009 Call). The EMRP Committee nominates ‘facilitators’ to play a moderation role within the NMI community during the JRP proposal development process (Stage 2). This is a logical ‘demand-control’ strategy, which is aimed at achieving a degree of alignment between in kind bidding and the national budget commitments. Of course, the final decision on which JRP proposals are selected is outside the control of the EMRP Committee.

Figure 6: Cumulative In-Kind for 2009 and 2010 Calls

3.3 Integration of National Metrology Research Programmes

3.3.1 Scientific integration

Common definition of research topics for the EMRP project calls

The concept of scientific integration in relation to measurement science can be considered at two levels:

1. Coordination of national investments in the research activities of the NMIs
2. Coordination of metrology-related research activities within the wider research community including, but not limited to, the DIs

The scale of the latter community has increased in response to the biological and chemical measurement issues that need to be addressed to enable the safe application of new technologies and deal with the grand societal challenges. This interdisciplinary trend in measurement science has already been discussed in Section 2.1.

The 'Grand Challenge' approach that is central to the EMRP has also encouraged more interdisciplinary cooperation both within the NMIs and between the NMIs and DIs. To a lesser extent, this has also involved some institutes from the wider research community but at a marginal level. Also, the EURAMET Technical Committees, which are composed of experts from across the NMI/DI community, are now spending a considerable amount of time in discussing and proposing important research topics that fit within the wider European scope of the EMRP. In discussing these potential research topics and deciding on which topics will be selected for further consideration, the EMRP Committee (which consists of NMI representatives only) takes a joint strategic view of the priorities for metrology research across Europe. The result is that an estimated 50% of the national investment in the participating NMIs is now coordinated within the scope of the EMRP and thus it is clear that considerable scientific integration of core national funding is being realised.

However, as the difference in allocated money between the large countries with their large NMIs and the smaller countries with their smaller NMIs is considerable, further consideration should be given by EURAMET and the EMRP Committee to safeguarding the position and interests of the smaller NMIs. There is a high risk with the current model that the needs of the smaller, developing NMIs/DIs are not properly addressed. Options to improve the situation would include:

- Creation of European centres of competence in metrology research and bundling decentralized competences/capabilities in a network of researchers and institutions working on defined topics.
- Coordinated planning and sharing of special research facilities, avoiding unnecessary double investments.

A major barrier for the small and developing NMIs/DIs is their limited capability to participate with expert staff and a reasonable financial share. This creates a strong risk that the existing

gap in competence and capabilities between the well established, big NMIs and the developing, small NMIs will become bigger instead of smaller.

There is less evidence of scientific integration at the national level. Discussion and agreement on the selection of the metrology research areas to address grand challenges has led in several countries to an alignment of the national metrology research programmes with the EMRP priorities. Some countries are now engaged in scientific metrology for the first time. However, the degree of scientific integration at national level is inhibited by a lack of inter-ministerial coordination in most countries because different ministries have responsibilities over part of the broad metrological area. This issue becomes particularly important as NMIs focus more of their attention on the grand societal challenges like healthcare, food safety and the environment. In those cases where there is a lack of engagement between the NMI/DI and the technical priorities of the societal ministries it can therefore be assumed that the countries concerned do not fully contribute, to and benefit from, the EMRP.

Third parties (i.e. non-NMI/DIs) are involved in proposing and executing the EMRP research projects but their involvement and influence appears quite limited. Whilst it seems appropriate that the main focus of the EMRP should be on the development and strengthening of the position, competences and capabilities of the NMIs and DIs more attention should be paid to attracting competent third party experts that can add value to the NMI/DI community.

One of the major points to consider here is that the in kind resource commitments are contractually bound to the dedicated institutes (normally the NMIs). Equivalent commitments from other third party programme owners, ministries, institutes and/or companies would be needed to overcome this barrier but this would clearly lead to a more complex EMRP. Opinions among the EURAMET members are mixed; some favour a restricted approach focussing on NMIs, others are willing to take a more open approach of letting third parties in, supporting them with EMRP funds and have them competing with the NMIs. However, the majority of NMIs favour an NMI-focussed, and controlled, EMRP.

Nevertheless, the current EMRP is strengthening the much needed cooperation with academia and other scientific research organizations. A good example of third party interest and influence is the move in 2010 of €3 million from Environment to Industry as a consequence of the validation and priority setting of the proposed and selected research projects. In 2011 a similar decision was made by moving €2.5 million from SI to Health. In both examples the influence of third party participation was noted.

The level of scientific integration through the Researcher Grants system is more disappointing and is obviously not having the desired effect. Some of the obvious problems are:

- Researchers home organisations have administrative problems to host grant recipients. So, excellent researchers like professors at universities wishing to spend part of their time for contributions in JRPs cannot be (co-)funded;

- Smaller and less advanced NMIs often do not have sufficient competent scientific staff or, if they have, they cannot be released from their normal work for long periods. Even in situations when the person can be released, their home NMIDI may not have the necessary facilities to apply the knowledge gained;
- Grant application procedures are too elaborate and time consuming.

The design of the Researcher Grant system needs to be reconsidered in order to make it fit for purpose.

The EMRP topics have been well chosen as all parties involved in the EMRP, including the members of EURAMET, the EMRP Committee and the Research Council have endorsed the topics and selected research programmes. The EMRP is globally admired and recognized and may lead to some further tuning of very expensive metrology research projects on a global scale, avoiding very costly duplications. The EMRP has also raised interest in countries and NMIs that are not actively participating.

Central evaluation with independent experts and central selection decision

The central evaluation with independent experts and the associated selection process is both professional and efficient. The refinement of the criteria applied for judging the quality and importance of proposed research topics has been demonstrated to be very helpful in making final decisions with respect to which projects will go on and which should not or cannot go on for budgetary reasons.

Further consideration should be given to the availability of experts from industry as well as from academia and other institutes with a sufficient level of metrology knowledge. Currently, there appears to be a lack of referees who are competent to properly judge both the scientific quality of projects and the degree to which they will impact on industry and/or society. There is also a perception that the overall selection process is dominated by physics-orientated experts, and the related scientific capability of the leading NMIs, and thus there is a need to be more open to other relevant European centres of excellence. Only then can it be expected that the best projects will be selected in support of the EMRP objectives.

3.3.2 Management integration

The dedicated implementation structure and its effectiveness

EURAMET has put in place a professional organisation that is working well. Where needed, improvements have been and are still being made so the EMRP can be considered as effective in its implementation. The current management structure is regarded as both efficient and supportive. The EMRP Management Support Unit works professionally and efficiently.

Nevertheless, there is a need to explore ways of reducing and simplifying unnecessary bureaucratic procedures. The administrative burden for coordinators and participants in JRPs is considered too high and creates a risk for the longer term acceptance and efficiency of the

EMRP. Currently, the execution of projects may be delayed by the difficulties in approving the research excellence and/or mobility grants.

Another concern expressed by several NMIs is the necessity to have sufficient and competent project coordinators, which are really ready to start on time and maintain the planned time schedule. There seems to be a general lack of professional competence in the management of complex international joint research projects and it would therefore be logical to provide (possibly mandatory) training at the commencement of each batch of new projects. An example of this is the Intelligent Energy Europe (IEE) programme that is managed on behalf of the Commission by the Executive Agency for Competitiveness & Innovation (EACI). The coordinators for all new funded projects from the annual IEE Calls are required to attend a two day training course.

The use of integrated common contracts

The JRP contract, which is signed by EURAMET and the JRP Coordinating organisation, has a standard core part. All the other partners in the project sign a copy of Annex III of the contract, thus acceding to the contract. In Annex Ia and Ib of the contract the unique technical work and the costs of the project are described. To simplify and reduce the work in preparing a contract, and therefore speeding up the contract process, EURAMET has developed guidance for preparing project proposals in such a form that when the project is selected and approved the major parts of the project description can be copied into the relevant Annex of the Contract. In addition to the JRP Contract, the partners in the project sign among themselves a 'consortium agreement'. EURAMET only needs confirmation that such a consortium agreement is in place, before the prepayment to a project is executed. However, Intellectual Property issues have not been hindering the execution of the selected research projects.

The Researcher Grant contract also has a standard core text and an additional 'Research Schedule', defining the work to be done. This contract has been improved in 2011 and now covers only essential details. Of course, the researchers work in another country on the basis of the local national legislation and employment contracts. In spite of these improvements, the majority of the participating NMIs are of the opinion that the Researcher Grant system is not working properly and should be reconsidered.

3.3.3 Financial integration

Central selection and co-funding by the participating States

The huge differences in the budget commitments of the participating countries/NMIs compromises the overall success of the EMRP. The perceived consequence of this is that the EMRP is helping the well developed and big NMIs to become stronger, while the small developing NMIs are not really served. There are also considerable differences among the countries/NMIs with respect to the different cost factors, in particular the labour costs per month. These can create significant funding differences for similar activities.

The evaluation and priority ranking is done by independent expert referees. The final decision on selection of projects to be funded, taking into account the judgement by the independent experts referees, is made by the EMRP Committee. So far, the EMRP Committee has always fully endorsed the recommendations of the independent expert referees. Also the Research Council has endorsed all selected research projects.

With one exception in the first call (when a project that straddled the budget cut-off line was funded with a much reduced budget and scope) the selected projects have been co-funded by the participating states from their pre-committed budgets. It has since been agreed that marginal projects should not be allowed to proceed unless they can be fully funded because the final results may not meet the originally set goals. Some NMIs feel very constrained by their original budget commitments and would like more flexibility to increase for example their reserve budget.

The EMRP has probably reached the practical limit of financial integration because in many countries the in kind contribution is taken from the block NMI budget, rather than wider national research funds. This has enabled an extremely high level of financial coordination to underpin the scientific integration that is being achieved through the annual Calls.

The allocation of the Union contribution to the selected projects

The EU contribution has, in all cases so far, been allocated to the projects in accordance with the ranking list and this co-funding is highly valued. With the benefit of hindsight, a number of countries would like to increase their national commitment in any future EMRP on the assumption that the financial model would have 50% EU co-funding. If the co-funding was lower, the commitment would be significantly reduced as the costs involved and time spent on preparing project proposals is considerable.

The 'real common pot' for researcher grants is not working as intended. It is not sufficiently attractive for enterprises, academia and/or other institutes. Neither is it practical for small NMIs/DIs that may have only one expert in a specific field. The mobility and excellent researcher grant system is considered to be an essential element of the EMRP, so it should be maintained, but implemented in a more flexible way and with less bureaucracy and simplified rules.

Progress towards more financial integration

So far, there is no trend towards, or rationale for, further financial integration. There are a wide variety of internal cost structures and budget systems between the participating countries and their NMIs, particularly in the countries with more advanced scientific metrology systems. It may be that those countries that are trying to develop their capacity may adopt EMRP financial systems but this would have only a marginal impact on the overall financial integration as the current EMRP model is not sufficiently supporting the needs of small and developing NMIs.

3.3.4 In general

The 'Virtual Common Pot' model

The 'virtual common pot' works in a sense that it is compatible with the block funding nature of NMI/DI funding structures and the participants generally get back more than their national cash contribution. The main problem is that the smaller countries do not have the capacity, or budget allocation, to participate in advanced metrology research projects. This is a critical issue for the longer term future of the EMRP. It will therefore be important to consider EMRP adaptations and/or accompanying measures so that small countries and their developing NMIs/DIs can effectively participate in the EMRP.

Need for further management and financial integration

The EMRP is considered to be an excellent model for scientific collaboration by the NMIs as it provides them with a centrally-managed, dedicated structure for joint research and enhanced development of national capabilities and infrastructure. The EMRP is well managed by EURAMET and its EMRP Committee. However, the big NMIs benefit more than small NMIs.

Further scientific integration would be necessary to achieve a truly integrated European Metrology Research Area that has more open access to the relevant centres of excellence within the biological and chemical science community in Europe, including those that are linked to the societal ministries and agencies

Some tuning of national research programmes is also evident and participating NMI are better realising their relative strengths within the metrology ERA. This will hopefully lead naturally to the evolution of national or regional centres of metrological excellence that are better networked across Europe but EURAMET could show more leadership by initiating strategic debate on how the EMRP can be an enabler for a framework of European centres of excellence in key areas of metrology for the future.

Further financial integration will be difficult because of the block grant system of research funding for NMIs and some DIs. Cross-national funding is not considered feasible although, if it could be achieved through a restructured grant system, it could help to better build scientific metrology capacity throughout the less research-intensive countries with limited resources. This would, of course, require some changes or adaption to the JRP funding criteria. Small and developing NMIs/DIs could be served better by a more flexible application of the rules under the EMRP but this may be inconsistent with the current FP7 co-funding. Another option is a bespoke metrology infrastructure development programme. This could be combined with other funding, for example by using the EMRP to leverage EU Structural Funds. EURAMET should discuss these issues and develop and agree on a strategy for development of the metrology infrastructure in Europe for the coming decades.

4. Progress towards the Objectives of the EMRP

4.1 General Policy Objectives

The "fifth freedom" – the free movement of knowledge within ERA

The EMRP is still in the first half of its seven year life cycle (the first of five Calls was launched in 2009) and none of the research projects have been completed. Even if it is too early to give definite answers, we can say that the Programme should certainly contribute to more 'political' objectives, among them growth. A part of the Programme is clearly dedicated to cooperate with industry (both traditional and new technology industries) and to respond to its needs. Certainly industry benefits from it, even if indirectly, and this will support growth and jobs.

While previously metrology research was oriented towards more traditional fields of activity like mass, length, etc. the focus is now oriented towards the interdisciplinary Grand Challenges of energy, environment, health and new technologies. This is a novelty for many NMIs that still have a strong orientation towards the physical sciences. The demand for new measurement solutions is more of an interdisciplinary nature, which requires NMIs to either develop new competences (related to the biological and chemical sciences) and/or be more open to collaboration with external centres of excellence.

The EMRP has given the metrology community a strategic framework for joint R&D in topics that are not just about common societal/technology interests but also the more fundamental SI System, all of which require adequate critical mass to reach the objectives more effectively.

The NMI community meets regularly and is now able to jointly address research topics. The technical committees of EURAMET include representatives from the DIs but the prioritisation of Strategic Research Topics is decided by the EMRP Committee, which is a forum of NMIs only. Each project is carried out by a consortium that usually has, on average, ten partners from eight countries. In this way, the knowledge of the dedicated national centres for metrology (NMI/DIs) is brought together, applied to the common challenges of Europe through JRPs and thus contributes to the free movement of knowledge in the ERA. The researcher grant and mobility schemes also promote the fifth freedom but their impact is quite limited so far.

The realisation of the European Research Area (ERA)

The EMRP is definitely contributing to the creation of the ERA and builds on the previous initiatives that started the metrology community on this path. The positive aspects of this programme are indicated by the fact that EMRP is attracting the attention of other metrology communities in the world. Sometimes it happens that the European metrology landscape is seen as one entity.

The EMRP has set common priorities for scientific and technology areas amongst the NMIs and encompasses about half of their core research budgets. The scale of the EMRP is sufficient to create a genuine core ERA in metrology but will need to be more inclusive of the wider research community to be the platform for a true European Research Area in

metrology. National NMI policies and priorities are also being influenced in some cases due to the joint programming processes, which give a common understanding of priorities.

Addressing Europe's key societal challenges

The fruits of the EMRP joint research projects should, in due course, help Europe to better respond to societal challenges as it was set up with this goal in mind. EURAMET has strategically shaped about half of the EMRP budget around the grand challenges of environment, energy and health as well as new technologies. It has also identified specific possible contributions to security issues. In most cases, this is the first time that such topics have been addressed within the national metrology programmes.

Metrology, as such, is a supporting discipline (an enabling technology), but a crucial one for many activities. In the past, traceable measurements were not perceived as so important but today traceability is a must.

The focus on societal challenges is encouraging more interdisciplinary approaches and engagement with other stakeholders. There is strong interest in getting users involved in relevant projects. Some of the smaller NMIs seem to favour more applied projects.

The EMRP allows the metrology community to focus on grand challenges projects but these tend to be at the basic research level and there is a risk that the outputs will not, by themselves, lead to better societal outcomes. In fact, in some cases knowledge transfer instruments related to industrial take-up and support to standardisation are missing.

4.2 Specific Objectives

Structuring the ERA

Coordination and integration are the starting points of the construction of the EMRP, as well as the main goal.

This particular programme seems to be achieving a level of integration never achieved before. Around 50% of the dedicated NMI budgets are now coordinated within the EMRP and this represents a significant proportion of the total investment in metrology research across Europe. However, the degree of coordination is significantly lower for those countries that have a less centralised metrology research structure or in cases where the NMI/DIs do not have a strong scientific metrology function.

EMRP is contributing (almost compelling) the coordination and integration of national programmes. The joint preparation from the very beginning of the projects, involving 'big' and 'small' NMIs, is really helpful in this respect. There are some indications of alignment between larger countries and smaller countries that have scientific excellence in niche areas.

The joint preparation of EMRP roadmaps is influencing national priorities. The elaborate process of designing each annual call, starting around one year before the launch of the call, seems to have a very beneficial structuring effect as it clearly influences the background behaviour of the national players.

The programme is deliberately aimed at addressing the grand challenges, once out of the

reach of single NMIs except, perhaps, PTB and NPL.

Improving the efficiency of Europe's fragmented public metrology research approach

The EMRP is a good incentive if we think of an efficient Europe in all fields of activity, including metrology as it shows how advantageous it is to coordinate the work in order to make better use of all available resources.

Even if it is too early to say if the fragmented European metrology research approach has been definitely overcome, the efficiency and coordination of the national metrological research programmes have been improved. There is widespread conviction that coordination and steps towards integration avoids duplication and researchers are working in a complementary, coordinated way.

The main stimulus comes from proximity to the social, economic and productive issues. All NMIs experience this proximity so it is evident that there are strong reasons to work together.

The national systems are extremely diverse and the EMRP is imposing a highly structured management process on all participants. Even if there are some complaints about an excessively structured management process, thanks to the Programme, many NMIs have learned how to work efficiently with more professional management systems.

Unfortunately the temptation to protect and defend one's autonomy is still present in some entities but the Union co-funding is crucial in overcoming reluctance.

Increasing the impact of the national metrology programmes

The EMRP is still in the first half of its duration and in many cases final results are not yet apparent. It is too early to fully judge scientific and even more a tangible economic and societal impact. The best proxy is the projects that were funded under the prior IMERA Plus initiative as these were the pilots for the challenge-led approach.

Nevertheless a rather widespread conviction is that a more efficient approach to grand challenges will surely increase impact. Expectations are of a much higher impact due to the fact that the programme deals with bigger and more challenging projects.

The EMRP addresses scientific and technical challenges that could have never been addressed without the Programme. It brings together previously sub-critical national resources, adds European money and brings forth a project having the critical mass necessary to achieve greater overall impact.

Expectations are also positive thanks to the joint work in proposing and selecting the topics. Properly selected topics contribute to foster excellence as the process facilitates the pooling of data, expertise, financial resources and achievement of the necessary critical mass.

As for scientific excellence and impact it is requested that, for future calls, these two criteria will be weighted 50% higher than the other evaluation criteria.

Fostering sustainable cross-border cooperation

The Programme contributes to remove barriers that are represented not so much by different currencies or languages, but by different cultures, ways of working (strict programming versus more freedom) and communicating (strict confrontation versus diplomatic relations). Also lack of inter-ministerial coordination and collaboration constitutes a barrier: measurement issues in areas like health, energy and environment are under the responsibility of different ministries.

The ways of working for all NMIs and DIs have been affected by the Programme; NMIs are now 'compelled' by EMRP to work horizontally rather than vertically (i.e. by technology theme).

Whilst it is evident that the Programme fosters sustainable cross border cooperation, at the same time it is to be admitted that the mobility aspect linked to the grant schemes remains problematic. The grants are not really making the difference vis a vis cooperation and mobility. The most successful cases of cross-border mobility are doctoral students drawn from a small country, who work in a developed institute in the frame of a JRP, get their training there and later are hired in an emerging institute.

There are different aspects that need re-consideration: the present schemes are too complex and expensive to administer; they select only a 'fraction' of the outside world; the big labs don't want to release the valuable experts; the small ones don't have the people; present rules are creating fundamental barriers to the involvement of senior academics (some are delivering paid services, others working on multiple projects). Everyone wants good people to remain. No one wants them to go out.

There is room for improvement involving more systematically researchers and scientists from other fields. At the moment there are no practical means to involve senior academics in EMRP projects. For the future, it would be desirable to find a way to achieve this or at least to involve the leading external centres of excellence in the JRPs.

4.3 Metrology Research Objectives

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

Since the eighties there has been a long tradition of virtual cooperation within the metrology community. The Programme deliberately chose cross-disciplinary themes, addressing the grand challenges and using the emerging technologies, which cut across the traditional disciplines.

The EMRP is a positive stimulus to open up, fostering interdisciplinary and multidisciplinary collaboration; there is awareness of the importance of new emerging technologies. The topics addressed are by definition interdisciplinary and multidisciplinary (environment, health, energy, etc), and cooperation is taking place among scientists of different countries and regions. This helps to a greater extent cross border cooperation and integration.

The focus on the grand challenges (and specifically energy, environment and health) is widely regarded as the key success factor of the EMRP so far. As well as applying a critical mass of coordinated research resources aimed at developing metrology solutions to common societal challenges it also fosters interdisciplinary approaches. This also encourages the NMI/DIs to be more open about how they can access the expertise of the wider research community.

The EMRP also stimulates the strengthening of existing specific expertise in the different NMIs and DIs, possibly leading to a world class measurement standards and calibration capability.

Enabling research capacities building

The EMRP has created aspirations to build national research capacity amongst the smaller NMIs and those in the newer Member States. However, in most cases these aspirations are being frustrated by a lack of sufficient involvement in both the JRP and researcher grants. This has been discussed in some details in Section 3.3 above but the basic problem is a lack of both research personnel and insufficient national budget for JRPs. The former makes it very difficult to exploit the mobility grants. The latter means that their involvement in research projects is at best marginal. Seven of the 22 countries have an in-kind budget of less than EUR 1 million to co-fund JRPs in 11 thematic call areas over five years from 2009 to 2013. This has apparently encouraged some of the smaller countries to be quite strategic and prioritise specific niche areas for participation. The other issue is that the scientific knowledge gap is currently too big between the more advanced NMIs and the others. In general, small countries with developing metrology research, including new Member States, face difficulties to participate in high-technology and/or advanced areas of metrology as the orientation is very much towards the basic research end of the innovation spectrum. It is therefore not practical for those NMIs that operate mainly in the field of legal metrology at the national level. Some kind of knowledge transfer activity would be a better entry-level option for them to increase their participation in scientific metrology.

It is important to understand the needs of different countries arising from their respective economic and societal situation. Each country needs to consider what its priorities should be to achieve its national metrology objectives within the framework of EURAMET and the EMRP.

While the conviction is that the number of new EU Member States involved has to be

increased, it is to be underlined that even non-participating countries benefit indirectly from the EMRP through the EURAMET platform that provides wider support to its NMI members beyond the EMRP.

Open access to unique research infrastructures and facilities

It is clear that the research infrastructures and facilities of the larger and more research-intensive countries are being used for the JRPs although there has been a culture of open access within the European NMIs for many years. The main difference since the dawn of the EMRP is that the infrastructures are being used in a more coordinated way through joint research projects that have emerged from an elaborate scientific integration process. This may mean that some institutes will emerge as the European centre of excellence in specific areas of scientific metrology but there does not appear to be any strategic agenda to encourage this within EURAMET or the EMRP Committee. In contrast, the EMRP does not appear to have an effective means of providing access to unique infrastructures within the wider research community.

Increase generic collaboration with the relevant science community at European level

The EMRP explicitly addresses new technologies in a dedicated call, including nanotechnologies, functional materials, biotechnologies, technologies related to safety/security and ICT. New and interdisciplinary technologies are also covered by the other thematic programme calls such as Health, Industry, new SI, Environment and Energy.

While the potentialities to increase collaboration are there, the general view of stakeholders is that the researcher grants have not been effective in enabling access to relevant scientists and academic staff in the wider research community. There are a number of barriers ranging from lack of mobility to employment contracts that are inconsistent with the grant rules. The outcome is that the EMRP is regarded as a more or less closed programme as far as the wider research community is concerned. Of course, it has been reported earlier that 40 REG researchers are already participating in the EMRP, and also a significant number of unfunded partners, but there remain major barriers to collaboration with the best European researcher in academia and other institutes. The biggest NMIs (PTB and NPL) are able to indirectly recruit more PhD and post-doctorate students from national resources because some of their core scientific people are being co-funded by EMRP projects. This is a good outcome but would have a greater overall impact if some of this resource was applied to address the knowledge gap within the developing NMIs. The barriers to collaboration with the wider research community are probably more critical in countries where there is a relatively low level of scientific capacity in the NMI compared with the wider scientific capacity in those countries (e.g. new Member States and countries where the NMI is mainly concerned with legal metrology).

Modernisation in the programming of national and European research priorities

The EMRP is influencing the modernisation of metrology research in Europe, not least because of the proportion of the scientific resources that are being coordinated. This can, however, be regarded as an evolutionary process as the human and infrastructural resources are mainly orientated towards the fundamental technological disciplines of metrology that

are based on the physical sciences. As a matter of fact consortia are still being developed between peer groups in specific technologies with limited involvement of other disciplines; 'big countries' (and EURAMET) seem still mainly organised by technology theme. It is to be said that there is room for much further improvement, although priorities are now being set on the basis of the needs of society, regulators, standardisation bodies, industry and other stakeholders.

The NMIs are generally weaker in the chemical and biological sciences, which are more important in some of the new technology areas and also the grand challenges of environment, health and aspects of renewable energy. To some extent, the DIs provide some access to these wider disciplines but not all are active in scientific metrology. Furthermore, the wider scientific community that carries out measurement-related research seems largely excluded from the EMRP. The most important trend, to be further encouraged, is that the traditional scientific pillars of metrology are being bridged by the interdisciplinary projects in response to the grand societal challenges.

Foster mobility of "early-stage" researchers from NMI and DI

The lack of response to the two mobility grant schemes is perhaps the most disappointing aspect of the EMRP so far. Only five RMGs (researcher mobility grants) were funded in response to Stage 3 of the 2009 Energy Call (information on RMGs is not yet available for the 2010 environment and industry theme areas as the Stage 3 Call was only launched in March 2011). The early stage research mobility grants (ESRMG) opened in April 2010 and will remain continuously open but there is no indication that any such researchers have been funded so far. In some respects it is a little early to judge but anecdotal feedback clearly suggests a general dissatisfaction with the practicality of the researcher grants.

Europe should speak with one voice at global level

The European metrology system has gained international visibility and it is clear, from the NMI consultations, that both EURAMET and the EMRP are allowing Europe to speak with more of a single voice than before. The existing national centres of excellence are becoming stronger because of their leadership position in large scale JRPs and it is likely that some European centres of excellence will emerge. There is no agreed strategy, however, and this appears to be a sensitive territorial issue that could disrupt the balance of cooperation within EURAMET.

Metrology community groups in other macro regions (e.g. Asia, Australia, South America) are apparently quite interested in the EMRP model and the inclusion of SI-related topics within the 2010 Call will strengthen Europe's position within the BIPM.

Metrology research: a supporting activity for government regulation and standardisation

The position on supporting regulations and standards is mixed. On one hand, a memorandum of understanding has been agreed with CEN/CENELEC, which now also has a representative on the Research Council. On the other hand, the engagement with the national societal ministries and Commission DGs that are responsible for grand challenge regulations is weak. This is at least partly due to the different cultures and timing priorities that could only be resolved by a more effective mix of longer term joint foresight and a stronger orientation of

the EMRP towards applied research and knowledge transfer.

Support to industry and economic growth

Advanced metrology research can support industry needs in a number of ways. The most obvious is that it can enable more precise, faster and/or lower cost ways of ensuring quality standards in industry, commerce and public services like healthcare. In some cases, this is manifested through the calibration services of the NMIs, DIs and other accredited laboratories. In others, the new knowledge is exploited through innovative new products and/or services from the commercial suppliers of measuring instruments and certified reference materials. Although there is industrial engagement at Stage 1 of the thematic Call cycle (PRTs), and participation in some projects, there is also an apparent orientation towards basic research projects. This suggests that the main outcome of the EMRP will be new measurement science and there is a lack of complementary activities to foster the exploitation of existing measurement science in a way that will maximise economic growth in Europe. This gap should be addressed in any future programme, if it is to be consistent with the Innovation Union policy, perhaps by adopting some of the recommendations of the High-Level Expert Group on Key Enabling Technologies⁷.

For the EMRP it is too early to expect patents as the project portfolio is not sufficiently mature. One indicator is that the recently finished iMERA-plus projects included more than 100 scientific publications.

⁷ http://ec.europa.eu/enterprise/sectors/ict/key_technologies/kets_high_level_group_en.htm

5. European Added Value

5.1 Contextual Background

Since the European Research Area (ERA) was formally launched in the year 2000 the increasing efforts to reduce fragmentation and unnecessary duplication of national research efforts, as well as to secure critical mass and other benefits, gave rise to a number of instruments/initiatives to facilitate and support trans-national R&D. These can be grouped in a number of different ways⁸. In order to analyse the added value of EMRP, they either primarily support trans-national collaborative research (with somewhat limited or non-existent coordination of national programmes), or they focus on optimisation of ERA by strong member state's involvement through targeted coordination of national research programmes.

Instruments focusing on supporting trans-national collaborative research

There is a clear European added value in supporting collaborative research across Europe. It builds on pooling of resources and securing of critical mass to successfully address societal challenges such as ageing population or climate change, for example. Bibliometric data suggests that the scientific impact of research carried out using cross border cooperation is higher than that for purely national projects.⁹ In addition, trans-national cooperation contributes (to some extent) to less fragmentation and less unnecessary duplication of research efforts in Europe. A number of initiatives are apparent to support transnational collaborative projects based on the evidence of their added value.

The main programme supporting this type of 'research philosophy' at the EU level is the Framework Programme for collaborative research, which is now in its 7th multi-annual cycle (FP7) and is focused on supporting excellence of European research. Being a top down programme, FP7 is organised in 10 thematic areas relating to challenges, technologies and sectors. The research programmes are defined by members of the Management Committee involving representatives from all EU Member and Associated States. Annual work programmes in each thematic area are proposed by the Commission. Whilst general priorities are mostly in line with national strategies there is little evidence that the Framework Programme is influencing national priorities.

Instruments building on cooperation of national programmes

FP7 currently funds around 5% of overall public investment in research and development in the EU. This is around 25% of all R&D funding that is available on a competitive basis across the EU. In additional 4.5% of the national research spending of EU Member States is formally

⁸ ERA toolbox: a typology of European-level instruments. Prepared for CREST by European Commission services. 2009

⁹ European Commission, DG Research and Innovation based on OECD, "Measuring Innovation: a new Perspective" (2010); ASSIST project – Regular collection of bibliometric indicator, CWTS-Leiden university using Web of Science data

coordinated through contributions to inter-governmental organisations such as ESA, EUREKA or CERN¹⁰.

There is a clear rationale for further coordination in ERA, which is addressed by initiatives that focus on European-wide co-operation and co-ordination of national programmes. In addition to securing the critical mass needed to address societal challenges, the main European added value of transnational programme cooperation lies in enhanced de-fragmentation and in reducing duplication of research efforts. It also contributes to pooling of resources between member states, and possibly the Commission. Significant coordination of national programmes is currently addressed by initiatives at both EU and member states level with some limited contributions by international 'thematic' organisations, such as EUREKA, EMBL and ESA.

At the European level, three instruments are available within the FP7 Framework programme that focus on coordination of Member State activities; i.e. ERA-NET, ERA-NET Plus and Article 185. There are significant differences between the three instruments as detailed in the ERA-NET Plus Review 2010.¹¹ Amongst the three, only Article 185 requires a significant longer term integration of scientific, management and financial activities.

In addition to the instruments co-funded by the Framework programme, initiatives focusing on coordination of programmes are also organised by Member States. An example is the Nordic initiative on climate, energy and the environment. The main initiatives in the development phase are concerned with Joint Programming with 10 of these in progress, backed by a strong political commitment of the Council and the European Commission.

Among international organisations Eureka plays a prominent role. It focuses on pooling of national funding at the project level for the support of market-oriented industrial R&D projects. Since it is a bottom up initiative, where industry decides which projects should be developed, its impact on the coordination of national programmes is rather limited. The same holds true for EUROSTARS, the Article 185 initiative that is managed by the EUREKA Secretariat.

¹⁰ ERA Framework Public Consultation: Areas of untapped potential for the development of the European Research Area Document accompanying the on-line public consultation questionnaire on the ERA framework.

¹¹ J. Lock, J. Albaiges, J. Edler, J. Kolar, I. Lambkin, ERA-NET Plus Review 2010, Final Report of the Review Panel.

5.2 European Added Value of EMRP

The brief overview of trans-national cooperation in R&D demonstrates the complexity of instruments in the European Research Area. The panel thus firstly focused on whether the Article 185 was the instrument with the biggest European added value when considering the field of metrology. In this the panel draws on the ex –ante impact evaluation of EMRP (Ref 11), which analysed expected impacts of three alternative options; an ERA-NET, FP7 thematic action or an Article 185. This is shown in Figure 7.

Impact on:	Light Coordination (ERA-NET)	FP7	Article 185
Efficiency of coordination, integration of NMI and national programmes	Medium	Low	Very High
Effectiveness of coordination, integration of NMI and national programmes	Medium	Low	High
Grand Challenges	Medium	High	High
New MS: capacity building	Low/Medium	Low	Medium/High
Open access to infrastructures	Low/Medium	Low	Medium/High
Interaction with science community	Low/Medium	Very High	Medium/High
Modernisation of metrology system	Medium	Low	High
Mobility and human resource development	Low	Very Low	Medium
Global cooperation and position of Europe	Low/Medium	Low	High
Support to EU regulation	Low	Low	High
Growth: Service to industry	Low	Low	Medium
Growth: Support to emerging sectors	Medium	High	High

Figure 7: Ex-Ante Impact Expectations

With some minor deviations in the assessment of the EMRP as an Article 185, which is discussed in Section 6.1 (Impact) below, the panel supports the above analysis that demonstrates clear advantages of Article 185 over the other two instruments. FP7 would clearly be superior in terms of interaction with the wider science community.

The panel then focused on evaluation of the European added value of the initiative itself. 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.¹²

Reaching of critical mass

EMRP brings together research efforts of members and associates in the field of metrology from 22 countries. This allows for critical mass to address even complex, interdisciplinary topics such as the grand societal challenges, which would be beyond the capacities of a single country.

Pooling of resources and efforts

It is estimated that about 50% of total dedicated metrology funding in Europe is coordinated through the EMRP. It thus significantly contributes to pooling of national resources, which along with the EU contribution, amounts to a EUR 400 million single joint programme.

De-fragmentation and reduced duplication

De-fragmentation of research efforts and reduced duplication is achieved through both the elaborate planning and implementation of each Joint Call (joint programming).

Identification of research topics in EMRP have, from the onset of the action, been inclusive of various stakeholders although there is some bias in the selection process towards the NMIs. As a true joint programme managed and implemented by national representative bodies (mostly NMIs), as well as the wider research community and other stakeholders, it significantly contributes to shaping of European as well as national priorities in the field of metrology. The interviews with policy makers involved in EMRP revealed that the process also contributes to a shift from 'traditional' metrology topics to emerging fields linked to the needs of society.

Fragmentation and duplication in Europe is not only limited to research efforts, but also to the design and implementation of ERA instruments. The stakeholder interviews revealed that the transparent and effective governance and management processes of EMRP have increased the overall quality of governance and management of R&D in metrology in Europe. This is particularly true for those countries that have less developed metrology research activities. In addition to the lack of resources in metrology, such countries are often also underdeveloped when it comes to management skills and the quality of policy making.

Despite the undisputed added value of programme coordination at European vs. national level, some of the national actors expressed concerns about the high administrative burden of EMRP. The administrative burden of EMRP is light in comparison to FP7 for the Commission, whilst it is more intensive for the participants. However, considering that the management of EMRP has replaced a large part of national R&D activities, it is likely that the overall administrative burden of EMRP on participating states is still smaller than if

¹² M. Stampfer, European Added Value of Community Research Activities Expert Analysis in support of the Ex Post Evaluation of FP6, WWTF, 2008.

undertaken by each country separately (if carried out to a comparable quality and transparency).

As well as having established the contribution of EMRP to reduced fragmentation of research topics and design and implementation of calls, the panel considered also the effect on the researchers themselves. Although not usually a part of 'de-fragmentation' discussions, the panel recognizes the stress that too many different ERA initiatives with different participation rules may impose on the research community. Thus the instruments should be developed in a way that minimises the non-research burden on participants. From the user's perspective, the EMRP has a similar administrative burden to FP7, as it is constrained by the same rules. The positive effects of the elaborate programming stages, as well as a rather closed community, contributes to a larger success rate in EMRP than is the case for FP7, which contributes to a decreased overhead burden on the researchers. However, while the fact that the rules are modelled after FP7 makes EMRP in a way user friendly for researchers already used to FP7 rules, it also results in one of the recurring comments of the users that the implementation needs simplification. This is especially true when it comes to the Mobility programme of EMRP, which is considered one of the less successful parts of the programme. As discussed earlier, this is partly due to the small research teams in several NMIs and DIs, which cannot afford to support mobility as losing staff, even temporarily, is a major barrier.

5.3 Advancement of the European Metrology Research Area

The Panel had a common view that the EMRP is an excellent model of what can be achieved by coordinating core-funded national R&D programmes. Much of the concluding Panel discussions therefore focussed on how the platform of the EMRP could be used to enable EURAMET to go beyond pooling of scientific excellence and build a truly integrated 'European Metrology Research Area'.

The EMRP has considerably advanced the European Metrology Research Area

The current assessment of the impact and benefits of the EMRP can be considered timely despite the fact that it is only in the middle of its 3rd out of five scheduled call cycles. Some of the progress can be attributed to the previous iMERA and in particular iMERA Plus activities. Nonetheless, we can already assess the real benefits and areas for improvement.

The EMRP is enhancing cooperation at the European level.

This was already developing with the iMERA ERA-NET (and the bridging ERA-NET Plus) but the new tools, multi-annual funding commitments and modes of operation have enabled a step-change in collaboration between the NMIs and to a certain extent the DIs. Indeed, the different structuring tools such as the format of the JRPs and the questions addressed, along with all the mobility schemes that are associated with the calls, offer a wide array of opportunities for novel collaborative research and for addressing new topics.

These new structuring tools have not only improved integration between the NMIs and DIs but also enlarged the basis of collaboration. These facts are directly beneficial to the metrology community and are fostering an evolutionary development of multidisciplinary research in response to current and emerging societal and technological challenges. The new challenges for metrology are multidisciplinary by nature and will promote not only an evolution of the field of metrology knowledge but also a very much needed opening with the integration of external partners. In theory, all of the necessary tools are available in the operational structure of the EMRP. Also, the tools that complement the JRPs such as the mobility schemes will certainly contribute to the enlargements and integration of external partners in response to the more complex questions. In these new domains, there is also a critical need to promote accuracy, precision and traceability of the basic SI system. These new sets of questions and needs for more integrated responses can be easily illustrated with some key current environmental questions such as the quality of measurements related to greenhouse gases, or the measurement of oceanic pH drifting in some places to slight acidification and hence profoundly modifying the whole marine ecosystem.

A direct benefit of the structure and objectives of the JRPs is that they allow several partners to be present outside of the core beneficiaries (i.e. NMI/DIs). For example, if the appropriate level of stakeholder dialogue is achieved it should be possible to develop mutually beneficial cooperation between the metrology community and regulatory bodies. Indeed, the new European Water Framework Directive could be enhanced by complementary inputs from both NMIs and experienced academic scientists. Similar questions are also related to health

and the understanding and quantifying of certain key human metabolic functions. These domains will bring metrology in the field of proteomic, a new scientific domain progressing very rapidly.

All these new domains will be beneficial to the metrology community, necessarily enlarging their field of expertise and promoting collaborative projects with external partners resulting in the strengthening of the overall new outputs of metrology. However, compared to the traditional sectors of economy and the emerging new technology industries, the direct impacts of metrology on these societal issues will be more complex to assess.

Promoting the developments of NMIs and DIs within the ERA

The structure of the EMRP certainly facilitates the integration and participation in the JRPs of major NMIs and developing NMI's of some smaller or newer EU countries. If the process is well designed, then it will encourage systematic specialisation of the less research-intensive countries in a way that is supportive of the ERA development. The general collaborative schemes in the JRPs, if well integrated and organized within the JRPs, will generate cross expertise and complementarity between the major NMIs and hopefully integrate newly structured NMIs starting at a lower capacity level. It should result, with the right balance, in better cooperation and competition within the ERA.

These questions have long been raised. Within the framework of globalization of the economy, there are indeed recurring questions that are increasingly being asked concerning the 'privatization' of national metrology institutes (NMIs) and the growth of competition in the field of metrology¹³. If, in order to increase the efficiency of metrological activities, some competition should be permitted, the structural implementation of the JRPs and partnership structure should raise the level of new NMIs. This may prevent 'privatising' questions about the NMIs, which should ideally stay under the authority of their national respective governments because of the infrastructure role they play in the hierarchy of measurement standards for legal metrology and international trade.

The general benefits of the EMRP so far can be summarised as follows:

- Despite the relative immaturity of the joint research portfolio it is clear that the EMRP has already been successful in contributing to opening up collaboration between NMIs and DIs.
- The development of projects (JRPs) and array of formulation and research schemes clearly evidences the changes in implementation of partnerships between NMIs and the opening to other participants for the co-development of these projects. This is strengthening inter-EU collaboration and Europe's position within the global metrology community.

¹³ Kose, V., Competition and cooperation among national metrology institutes for achieving an efficient and sustainable global metrology *Metrologia* 37 (2000) 75-80

- An important point, in the implementation of the EMRP systems, is the fact that it has contributed to promote a number of staff exchange grants between NMIs.
- Another positive point is the increasing contribution of industry, and academia to a lesser extent, in large scale JRPs. This fact is certainly linked to the reformulation of the objectives of new trends and challenges of metrology research in general.

In summary, the Panel is able to confirm that the implementation of the EMRP has enabled a radical improvement in collaboration between NMIs and DIs and a limited opening to industry and academia.

But there are limitations to what it has achieved

The direct benefits of the EMRP that are obvious and described above allow a series of issues to be raised concerning the future of the EMRP and/or any successor initiatives. If these issues are not addressed then they may detract from the excellent progress that has already been made and could even be counter-productive for the longer term aspirations to develop the metrology ERA.

The metrology needs for Europe go beyond the capacities of the NMIs

Analysis of partners in the funded JRPs indicate that the actual opening to external participants is still quite limited and falls short of one of the core objectives: opening of the system to the best science. The complete analysis of all JRPs since 2009, addressing new challenges for metrology, reveal that whilst there is indeed a strong promotion of collaboration between NMIs, the engagement with external centres of excellence is still quite limited. We can identify three types of external partners; industry, academia and public sector organizations.

This diversification of participants within the JRPs can be considered as a first success (as mentioned earlier) since it clearly underlines the significant progression of NMIs integration and opening up of the project to outside partners. But it also suggests that this effort of opening should still be strongly promoted since a careful analysis of outside partnerships clearly illustrate that these partners are not necessarily the best experts in the respective domains and are most often selected as usual or natural partners/relations of one of the other NMI. This understandable but limited approach to opening necessarily hampers the aspirations for excellence and integration of best science within the ERA. Indeed, the grand challenges require multidisciplinary approaches that at the moment are mainly developed and implemented within the NMIs and are lacking the involvement of outside expertise.

This critical point needs to be furthering emphasised if there is any future continuation of the EMRP. Opportunities to develop links between academia and industry as well as other agencies should be facilitated more systematically in particular under the running initiative to prepare for any future continuation. The extension of the questions addressed by the grand challenges is an excellent opportunity to open-up and strengthen the expertise of the NMIs by close collaboration with academia and industries but with open information and dedicated

tools to facilitate these objectives. Indeed, there is a general unawareness of the essential challenges now faced by the NMIs and qualified answers will not be appropriate if only addressed by the NMIs. There is a definite need to improve the knowledge flow between the NMI's and the wider research community - and a need to develop tools to promote these exchanges. It can certainly be desirable that the level of participation of outside partners should be well in excess of the current 10% for researcher grants and mobility schemes. This would open up the EMRP to experts from other disciplines and communities whilst still allowing EURAMET to 'own' and drive the joint programme in line with their modernization mission. Many technical issues or discoveries have already been addressed in academia or industry but the rigor of metrology and measurement traceability is usually lacking and the synthesis of knowledge between the wider scientific community and NMIs is paramount for the grand challenges to be faced at both regulatory and market oriented innovation level.

The metrology ERA needs to be more supportive of the less research-intensive NMIs

The strategic focus on how the metrology community can help address the grand societal challenges can also be a factor of promotion and integration between the NMIs from the leading countries in Europe together with countries that have been more recently integrated into the EU. A careful assessment of all the leading JRP's also clearly illustrates that most of them are led and managed by the major NMIs (i.e. the more research-intensive ones). This was probably inevitable given the huge differences in national commitments based on their considerable differences in expertise, equipment and associated network of academic or industrial partners. However, if no care is taken, this will contribute to enlarge the scientific and technological gap between the major NMIs and those from the newer Member States that need help to develop their national metrology capacities.

The tools already in place, such as the mobility schemes, are not as efficient as expected. The mobility grants were intended to benefit the new NMIs or DIs for gaining experience and knowledge with the larger NMIs. However, these mobility schemes have not achieved the expected objective for a number of reasons. Firstly, it is often the most experienced scientists from the new NMIs who would benefit most from the opportunity of mobility but they are generally indispensable for the national organisation. Secondly, usually there is a significant gap in equipment and infrastructure that makes it difficult to exploit the knowledge gained on return from a mobility placement.

The mid-term assessment of the EMRP is an opportunity to re-orientate the mobility, and other researcher, grant schemes in a way that will support the strategic development of the developing NMIs. They have the potential to play an important role in the economic development of their countries with support from EURAMET, EMRP and the leading NMIs in Europe. This will require a degree of 'smart' prioritisation and engagement with national policy makers to develop both internal capabilities and take advantage of the wider infrastructure across the European metrology research area.

Relevance to the knowledge economy

It is too early to evaluate the impacts of the EMRP on the knowledge economy as none of the joint research projects have been completed. Nonetheless, we can certainly anticipate that the topics and typology of the different JRP Calls could have an important influence on the safe and rapid exploitation of new scientific developments in areas like nanotechnology. If this is manifested in innovative new products from European industries then it will enhance Europe's international competitiveness with respect to North America, Japan and China. The latter has definitely recognized that nanotechnologies have a huge potential to bring benefits in areas as diverse as drug development, water decontamination, ICT infrastructures, and the production of stronger, lighter and perfect nanomaterials¹⁴. These are examples of scientific areas where metrology can play a major role and can support largely standards and market regulation.

It is therefore essential that EURAMET gives due consideration to how EMRP project results can be rapidly exploited by European industry and focus more attention on innovation and knowledge transfer activities in any future programme.

Relevance to EU Regulations

Finally, another domain that has both European and national implications is the promotion of new environmental regulations such as the European Water Framework Directive or the REACH¹⁵ Regulation, which entered into force on 1 June 2007. These are examples where the community of NMIs collaborating under the auspices of EMRP and EURAMET should be playing a leading role in developing underpinning new measurement methods. However, this will require a wide level of foresight activities and early engagement with policy makers and regulatory authorities at both national and European level. Only if this level of cooperation is achieved will EMRP be able to exploit its full potential in support of the Union policies.

¹⁴ Jia, L., Global governmental investment in nanotechnologies *Current Nanoscience* 1 (2005) 263-266

¹⁵ Registration, Evaluation, Authorisation and Restriction of Chemical substances

6. Panel Conclusions

The overall opinion of the Panel is that the EMRP is a well managed joint European research programme that has achieved a relatively high degree of scientific, management and financial integration. Euramet e.V. has also demonstrated that it can be trusted with the delegated responsibility of an Article 185 initiative. This seems to have been an ideal choice for the European metrology community to engage in joint programming.

The Panel is of the opinion that Euramet e.V. has created an excellent platform, through the implementation of the EMRP, to build a more inclusive European [Metrology] Research Area that goes well beyond the pooling of scientific excellence within the national metrology institutes. There are also a number of lessons for future joint programmes including some that are generic and others that are specific to the situation of the European metrology community – for example, the extensive use of national ‘institutional or block’ funding.

The conclusions and recommendations cover what the Panel believes can be improved within the current EMRP, options for the future and lessons for other joint programming initiatives.

6.1 Qualitative Impact of the EMRP

It is too early to judge the quantitative impact of the EMRP as none of the joint research projects have yet been completed. The current status of progress against the impact indicators is provided in Appendix A. The midterm conclusions on impact of the EMRP are therefore focused on the qualitative impacts.

In order to structure the conclusions on qualitative impact, the Panel felt it appropriate to compare the evaluation findings with the original expectations (i.e. the ex-ante impact assessment). This has already been introduced in Section 5.2 to support the discussion on European Added Value and covers 12 impact topics. These are described in more detail in Appendix B.

The comparison of the Panel's opinion and to what extent this matches with the original expectation is shown in Figure 8.

Impact on:	Ex-ante Expectations	Panel Conclusions
Efficiency of coordination, integration of NMI and national programmes	Very High	High
Effectiveness of coordination, integration of NMI and national programmes	High	High
Grand Challenges	High	Medium/High
New MS: capacity building	Medium/High	Low
Open access to infrastructures	Medium/High	Medium
Interaction with science community	Medium/High	Low
Modernisation of metrology system	High	Medium/High
Mobility and human resource development	Medium	Very Low/Low
Global cooperation and position of Europe	High	High
Support to EU regulation	High	Medium
Growth: Service to industry	Medium	Low/Medium
Growth: Support to emerging sectors	High	Medium/High

Figure 8: Panel Opinion on Qualitative Impacts after Two Years

The rationale for each of the qualitative conclusions can be summarised as follows:

Efficiency of coordination, integration of NMI and national programmes

In most respects the EMRP has been implemented in a highly efficient manner with dedicated staff and a culture of continuous improvement. The main issue is the operational

bureaucracy that creates a hidden cost for participants.

Effectiveness of coordination, integration of NMI and national programmes

The structures that have been put in place by EURAMET and the EMRP Committee have proved to be highly effective in pooling excellence in metrology research from within the NMI/DI community across Europe. It has been estimated that nearly 50% of the dedicated national investment in metrology research is now coordinated at the European level. However, the EMRP design clearly favours the most research-intensive NMIs. This means that it is a less effective model to build scientific capacity in countries with relatively low metrology capacities or to apply the best science from other institutes within the wider European research community. These two specific issues are discussed further below.

Grand Challenges

One of the successes of the EMRP is that it has led to a consensus on how the metrology community can help address the technical challenges in the energy, environment and health sectors. This will surely influence national policy to some degree. These transcend the traditional domains of metrology (based on the physical sciences) and should therefore encourage collaboration with those institutes within the wider scientific community that are more advanced in the relevant biological and/or chemical sciences. The selection process for Strategic Research Topics for each Call, however, could be more supportive of this desirable opening and go beyond the requirement "that relevant expertise and facilities exist within EURAMET to address those needs".

New MS: Capacity Building

Whilst the joint research programme is fully open to all NMIs and DIs the reality is that some participating countries do not have either the resources (mostly financial) or the expertise to participate effectively. In some cases the participating budgets are two orders of magnitude below that of the largest countries. Also there is a huge intellectual gap between their core business (legal metrology) and advanced scientific R&D.

Open Access to Infrastructures

The NMI infrastructure, particularly in the larger countries, has been quite open to peer Institutes for many years and the implementation of the EMRP has enabled these infrastructures to underpin the JRPs. This does not appear to be extended to relevant infrastructures across the wider research community nor does it appear that there is any strategic plan within EURAMET to develop a vision for an integrated network of infrastructures at the European level.

Interaction with the Science Community

As mentioned above, the focus on grand challenges (and also new technologies) should be fostering more mutually beneficial interaction with the wider science base across Europe but the perception is that the EMRP seems restricted by its existing capabilities and infrastructures (especially the NMIs). The main EMRP instrument to foster this interaction (Researcher Excellence Grants) does not appear to be effective for purpose.

Modernisation of Metrology System

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 specialization.

Mobility and Human Resource Development

Whilst there are two EMRP instruments to support mobility of researchers it appears that there are both staff-related and bureaucratic barriers to the effective use of these. The traditional, academic approach to mobility where the individual is relocated (for a significant time period) to an institute in another country appears too inflexible for the metrology community.

Global Cooperation and Position of Europe

There are some indications, even at such an early stage, 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.

Support to EU Regulations

The EMRP appears to be better engaged with European Standardisation at the policy level through participation of CEN/CENELEC in the Research Council but it is too early to judge whether the fruits of the JRPs will be more effectively transferred to the operational level (i.e. CEN Technical Committees or Working Groups). There are well documented barriers to exploitation of EU research through standardisation and there is no clear evidence of any EMRP activities that will enable this knowledge transfer process to be realised. In the regulatory field there seems a lack of policy-level engagement and dialogue with NMIs/DIs both at the European and national levels.

Growth: Service to Industry

In general, the JRPs are orientated towards the basic scientific level. There is a lack of a complementary knowledge transfer scheme to enable rapid exploitation of new science both through new/improved technical services by NMI/DI's and innovative new products from the European metrology industry (e.g. scientific instruments).

Growth: Support to Emerging Sectors

The specific 2011 call for JRPs related to 'new technologies' is a good example of how the metrology community can support the growth of emerging sectors where there is a need to develop new or more accurate measurement methodologies. This is an area where there should be more collaboration with the wider research community either within EMRP projects or through coordination with complementary FP7 projects.

6.2 Recommendations for the EMRP

An overview of the Panel’s conclusions on the Impact of the EMRP (as discussed in Section 6.1) is shown in Figure 9. The panel considers that a relatively high convergence between the initial expectations and the achievements at midterm can be observed. Some expectations concerning the initial EMRP objectives may need more time to be achieved than others.

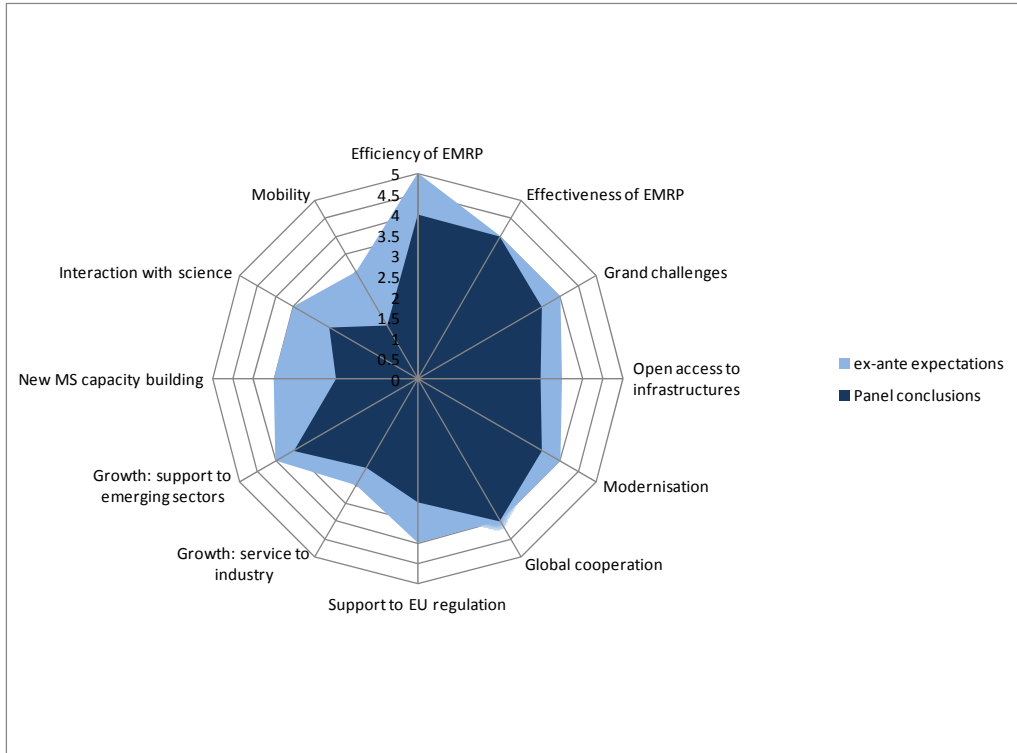


Figure 9: Overview of Impacts

Two main observations can be made from Figure 9:

1. The EMRP is performing very well in relation to most of the original expectations
2. There are still significant gaps between expectations and achievements at midterm in relation to three of the overall twelve initial impact topics: capacity building, interaction with the wider scientific community and mobility

In other words, reflecting on the Aims & Objectives of the EMRP (Section 2.2) it can be concluded that:

- The Panel is pleased to report that ***pooling excellence in metrology research*** has been achieved within the community of NMI’s. EURAMET and the EMRP Committee should be congratulated on facilitating the scientific coordination of nearly half of the dedicated national funding for metrology research in Europe.
- In contrast, the ***opening of the system to the best science*** has so far been limited and there is a clear external perception that the EMRP is still rather closed to the wider

European research community.

- In addition, it is clear that EMRP (as a research programme striving towards scientific excellence with its operational processes and financial instruments) is not having the desired effect in terms of capacity building in those countries with limited or no metrology research capability. Some countries have taken advantage of the programme to build capacity in strategic areas of interest but, in general, the capacity gap with the most research-intensive countries seems to be increasing.

Of course, the Panel acknowledges that the balance of resources is biased towards the 'pooling of excellence between the NMI/DI's' since only 10% of the overall budget is dedicated to the researcher grant schemes (including mobility).

The Panel's conclusions on the main issues that have been raised in the Interim Evaluation of the EMRP, and how these could be addressed, are summarised in Figure 10.

Expected Impacts	Key Issues	Options
Efficiency of coordination, integration of NMI and national programmes	Bureaucracy, time-to-contract, project management skills, quality of referees	Harmonise management procedures, project management training, KPI on time-to-contract, EURAMET database of metrology experts outside the NMI/Dis
Effectiveness of coordination, integration of NMI and national programmes	Budget variations, capacity variations	Use moderators to foster better inclusion, complementary EMRP instruments for the less research-intensive NMIs, more innovative use of mobility grants
Grand Challenges	PRT screening criteria excludes topics that don't fit existing NMI capacity	Stakeholder foresight workshops to prioritise SRTs, minimum % of SRTs that don't fit NMIs, twin track approach to new science and rapid exploitation of existing science
New MS: capacity building	Lack of resource and weak policy links	More innovative use of mobility grants, smart utilisation of Structural Funds, cross-border knowledge transfer from large NMIs
Open access to infrastructures	Lack of European integration, dominant centres of excellence	Foster JRPs that promote inclusion of embryonic centres of excellence, develop roadmap of European metrology infrastructure to 2020
Interaction with science community	REG scheme is bureaucratic and not fit for purpose	Incentivise cross-fertilisation between EMRP and relevant FP7 projects, new instrument(s) to enable practical access to best scientific knowledge
Modernisation of metrology system	Slow evolution towards interdisciplinary	New Euramet committee structures to reinforce interdisciplinary challenges, explore ways to better use grant schemes to foster links with external centres of excellence across Europe
Mobility and human resource development	Significant barriers to mobility of NMI/DI staff	Explore ways to allow more flexible use of mobility grants, explore options to exploit FP7 Marie Curie instrument
Global cooperation and position of Europe	Multiple voices	Develop consensus within EURAMET on formal coordination links between the EMRP and 3rd countries
Support to EU regulation	Lack of engagement with regulation policy makers	Foresight workshops with regulatory ministries/agencies, dedicated EMRP Call to support regulatory and standardisation roadmaps
Growth: Service to industry	Exploitation of new science	Technology foresight workshops to identify metrology needs, increase weighting for criteria related to rapid exploitation
Growth: Support to emerging sectors	Access to wider science base	Incentivise cross-fertilisation between EMRP and relevant FP7 projects, minimum % of nonNMI participation in new technology JRPs

Figure 10: Key Issues and Options

Some of the options could be realised in the current Article 185 initiative, whilst others are for consideration in the design of any future programme. The Panel was made aware by EURAMET e.V. and its EMRP Committee that both are keen to build on the success of the EMRP and address the weaknesses through a follow on action under the forthcoming Horizon 2020 Framework Programme for Research and Innovation.

The Panel Recommendations are therefore divided into current options under FP7 and options potentially for the future as described below. Whilst it does not wish to make presumptions regarding the funding situation beyond FP7, the terms of reference include a requirement to express its view on any future programme based on this mid-term evaluation.

Recommendations for the EMRP

The Panel has therefore made 20 recommendations. These include nine improvements that could increase the impact of the current Article 185 initiative, such as:

1. Harmonise further the management procedures and provide European research project management training for JRP coordinators and potential proposers
2. Establish a key performance indicator (KPI) for time-to-contract and set targets for improvement
3. Use expert facilitators to foster better inclusion of those countries with limited metrology research capacity with the aim of closing the gap with the more advanced countries
4. Explore the degree of flexibility that could be applied to the management of the mobility grants to overcome the relocation barrier (e.g. multiple mobility missions during the grant period to avoid relocation problems)
5. 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
6. Explore the potential added value of creating incentives to enable cross-fertilisation between complementary EMRP and FP7 actors and projects
7. Explore ways to better use the grant schemes to foster links with the best centres of excellence across Europe
8. Explore options for foresight workshops with regulatory ministries/agencies and the relevant Commission DGs
9. Increase the weighting of the impact criteria related to rapid exploitation within Europe

In addition, the Panel has proposed a further 11 recommendations that should be considered for the design of any future initiative and to enable EURAMET to reach for higher levels of European integration:

10. EURAMET database of metrology experts outside the NMI/DIs to support evaluation activities (the experience of the EUROSTARS Article 185 may be useful in this respect)

11. Twin track innovation and policy driven approach including separate instruments to enable both advancement of new knowledge and exploitation of existing knowledge. This would be consistent with the more integrated Horizon 2020 approach and allow developing NMI/DIs to make a more gradual transition from legal metrology activities to building scientific capacity
12. Develop a more practical instrument to enable better access to the best centres of excellence in the wider research community and/or dilute the prioritisation criteria that is biased towards topics that best fit NMI competence. This might include a % target for co-funded participation of non-NMI/DIs in new technology JRP and would help break the vicious circle that inhibits more openness whilst still allowing EURAMET to retain overall control.
13. Help developing NMIs and DIs to build scientific capacity that aligns with their national growth strategies through the use of both the EMRP and Structural Funds. This could perhaps be supported within the scope of the proposed knowledge transfer instrument (Recommendation No 11) to allow cross-border knowledge transfer from the big NMIs
14. Foster Joint Research Projects that promote inclusion and development of embryonic centres of excellence consistent with European strategies
15. Develop a joint roadmap of European metrology infrastructure to 2020 including the development of truly European centres of excellence and mutual access agreements
16. New EURAMET committee structures and/or composition to institutionalise modernisation objectives and reinforce the commitment to working together on societal challenges
17. Explore options to exploit, or align with, the well known and successful FP Marie Curie instrument. This could be designed to help foster links with the best centres of excellence across Europe
18. Develop consensus within EURAMET on formal coordination links between the EMRP and other leading metrology institutions worldwide
19. Dedicated EMRP Calls to support regulatory and/or standardisation roadmaps
20. Widely open foresight workshops to identify metrology-related barriers to the safe and rapid exploitation of new technologies

Some of these clearly go beyond the scope of a joint 'research' programme but the Panel believes that EURAMET should build on the success of the EMRP under FP7 and be encouraged to reflect further on a future programme; one that will be even more ambitious in terms of creating a deeply integrated European Metrology Research Area and position the Union as a whole at the top of this science worldwide.

6.3 Recommendations for Future Joint Programmes

Possible recommendations for future joint programmes involving Member States and the European Commission using Article 185

In view of the above discussion, the panel considered whether some of the current joint programming activities, or some other initiatives, could be successfully implemented as an Article 185. In this, the panel relied on the positive example of the EMRP.

As discussed extensively in this report, EMRP is a successful model of a joint European research programme, with a high level of managerial, financial and scientific integration. In the interviews the programme managers of EMRP strongly emphasized that its success relies on a long standing tradition of cooperation between the national metrology institutes that goes back several decades and a stable annual funding of substantial level, which can be partly integrated into a joint programme. The expert panel agrees that the following criteria need to be fulfilled in order to have a successful Article 185 initiative:

- scientific, management and financial integration
- common strategic R&I agendas of a significant scope and complementarily to the Framework Programme
- strong involvement of programme owners, policy makers, scientific and business communities
- multi-annual financial commitments of significant size from Member States
- strong managerial structure and practical experience in programme implementation
- solid rules of cooperation embedded in a legally binding governance model

Some of the currently developing joint programming initiatives are certainly wide enough in scope for an Article 185, however, they seem to be still at a stage, where they are drafting their strategic research agendas, based on which national resources (e.g. funding) might only be potentially allocated by the Member States. It is therefore too early in the process to consider appropriateness of the Article 185 instrument for Joint Programming initiatives as they stand at the date of this review.

In the opinion of the expert panel, it is particularly the financial integration criterion that will likely be difficult to meet in order to undertake an Article 185 activity. This is not only due to the austerity measures, which have negatively affected several of the member states' research budgets recently. Not all interested member states may have suitable running programmes to integrate within a joint programme, or the programmes are not flexible enough to do so. It also needs to be considered that in most EU countries, limited competitive funding is available for coordination at the European level, either due to the low R&D investment or because it is tied in non-competitive support to public research organisations (PROs, mainly Universities and research institutes). In the opinion of the expert panel it is thus particularly PROs that have the strongest potential for establishing future Article 185 initiatives, based on a stable, secured non-competitive annual funding similar to

the case of EMRP. In this respect, Universities and some RTOs (research & technology organisations) most closely resemble the core funding situation of the NMI/DIs).

Role of European Commission in future Article 185 initiatives

In the interviews the stakeholders involved with EMRP, from policy makers, NMIs and DIs to researchers acknowledged the European Commission's contribution to the development and implementation of EMRP. They also shared the opinion, that the role of the European Commission in EMRP is a suitable one, but have also expressed the need for more involvement of the DGs other than Research and Innovation particularly in the definition of research topics.

The EMRP serves as a good example of a running joint programme in the frame of Article 185. Nevertheless, a few potential challenges are identified, which deserve special attention in the planning of the future initiatives.

7. References

The following reference documents were reviewed by the Panel during the preparation of this report.

1. European Metrology Research Programme Outline, November 2008
2. Decision No 912/2009/EC of the European Parliament and the Council of 16 September 2009
3. Report on the ex-ante assessment of EURAMET e.V., 30 June 2009
4. Annex II to the ex-ante assessment– Action Plan
5. European Metrology Research Programme General Agreement RTD/B1/2009/EMRP
6. Annual Implementation Plan for 2010, 4 January 2010
7. Annual Implementation Plan for 2011, 6 December 2010
8. EMRP Annual Report 2009, 26 March 2010
9. EMRP Annual Report 2010, 28 February 2011
10. EMRP Interim Report, 1 June 2011
11. Impact Assessment Report, Commission Working Document, COM(2008)814 final, 3/12/2008

8. Glossary

BIPM	Bureau International des Poids et Mesures
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CENELEC	Comité européen de normalisation électrotechnique
COST	European Cooperation in Science and Technology
DIs	Designated Institutes
EACI	Executive Agency for Competitiveness & Innovation
EMBL	European Molecular Biology Laboratory
EMPIR	European Metrology Programme for Innovation and Research
ERA	European Research Area
ERAC	European Research Area Committee, formerly CREST
ESA	European Space Agency
ESF	European Science Foundation
ESRMGs	Early-Stage Researcher Mobility Grants
EUREKA	Intergovernmental cooperation on industrial and applied research
GPC	Groupe de Programmation Conjointe
FET	Field Effect Transistor
FP7	7th Framework Programme
ICT	Information and Communication Technologies
IEE	Intelligence Energy Europe
IPR	Intellectual Property Rights
IRMM	Institute for Reference Materials and Measurements
JRC	Joint Research Centre
JRPs	Joint Research Projects
iMERA	Implementing the Metrology European Research Area
MERA	Metrology for the European Research Area
MS	Member States
MSU	Management Support Unit
NMIs	National Metrology Institutes
NPL	National Physical Laboratory
PROs	Public Research Organisations
PRTs	Potential Research Topics
PTB	Physikalisch-Technische Bundesanstalt
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical substances
REGs	Researcher Excellence Grants
RMGs	Researcher Mobility Grants
SI	Système International d'unités
SMEs	Small and Medium Enterprises
SMT	Standards, Measurements and Testing
SRTs	Strategic Research Topics
TFEU	Treaty of Functioning of the European Union
TP	Targeted Programme
WWTF	Wiener Wissenschafts-, Forschungs- und Technologiefonds

APPENDIX

Appendix A: Quantitative Impact Indicators

A number of quantitative indicators were specified in the General Agreement. It is a little premature to assess the progress on most of these, as the JRP portfolio is still at the embryonic stage. The overall list and feedback from the EMRP Programme Manager on those that can be quantified at this stage are as follows:

- Number of Member States involved in EMRP and national programmes actively coordinated (22)
- Number of new Member States building up metrology capacities (10)
- Increase in metrology capacity of Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development (Will require a survey of those countries at the end of the programme)
- Number of research organizations (not being NMI or DI) involved in EMRP projects (65)
- Level of participation in the programme by outside researchers and research institutions (40 REG Researchers, 67 unfunded partners, 38 Research Institutions)
- Number of generic cooperation activities with non-European research actors (3 unfunded partners from outside Euramet countries)
- Number of research infrastructures jointly used in RTD projects (155 unique JRP participants)
- Number of research projects which are build on the specific strength of NMI and DI and their infrastructures and their impact on primary standards (35 - all JRPs selected so far)
- Number of mobility grants implemented (9)

The other indicators will be collected via the Final Reports of each JRP on completion

- List of advanced technologies employed in the developments of primary standards which can and should be transferred to new and challenging research activities;
- Number of EMRP projects with direct references to regulation;
- Number and quality of training activities;
- Number of Ph.D.s trained in metrology;
- Total number of metrology researchers involved in EMRP projects by age, class and seniority level;
- Scientific excellence of the projects and grants awarded as measured by the number of publications, patents and other scientific output indicators;
- Number and quality of activities related to metrology communication and diffusion;
- Number of publications;
- Number of presentations at congresses;
- Number of presentations at standardisation technical committees or working groups;
- Number of patents granted.

Appendix B: Ex-ante Impact Expectations

Coordination & integration of NMI and national programmes (cost reduction, reduce fragmentation and duplication, joint strategic direction)

Through a dedicated European metrology research initiative with Member States and the European Commission involved in joint programming the possibilities for coordination and integration will be strong given the leverage effect of additional EU funding and joint responsibility for the execution of the research programming. For some time national strategies have already identified the need to address challenges on the European Research Agenda. The difficulty has been responding to these needs. Individual countries do not prioritise on their own research in activities that will become an equal public good for all 27 Member States over activities that are seen to advantage the investing country. The establishment of a joint programme provides the solution, with common issues addressed in the joint programme, national issues addressed in the national programme.

Grand Challenges

The rationale behind the potential Article 169 initiative is to broaden the scope of metrology even further and to improve the potential in newer areas such as health, environment and food safety. The contribution from the EU would ensure a strong link to grand challenges, while the national interest in the programme would ensure a strong discussion on how to link European and national challenges and policy goals.

New MS: capacity building

iMERA has already led to capacity building across smaller countries. This has been done with a view to increased coordination. Art. 169 would – most likely – continue this trend.

Open access to infrastructures

The joint programming and the discussion about concrete projects as well as strategic planning of the programme offers a strong opportunity for infrastructure access and coordination, especially as it enhances the transparency across Europe. However, this is a potential that needs to be realised through conscious and systematic action rather than hoping for a self-dynamic process.

Interaction with science

The provision to spend 10% of the budget for grants for “outsiders” would ensure a minimal engagement, and care would be needed to guarantee that this engagement would be backed by institutional commitments behind the individual grants and that the grants are given not only to junior researchers or post docs, but to senior researchers from academia as well.

Modernisation metrology system

The option would substantially support the idea of modernisation. The national programmes would be modernised between themselves and especially through the integration and influence with the FP. Article 169 will aim at fostering excellence by calling for specialisation of certain national centres. As an example the UK National Physics Laboratory is not anymore

doing certain traditional work on pressure equipment and started very recently to advise UK companies to cooperate with the Italian National Metrology Institutes or Designated Institutes. This type of arrangement started in the perspective of closer cooperation between NMI under EURAMET e.V. and in perspective of the Article 169 Initiative. It shows the potential to create real centres of excellence in specific important fields and allows for higher degrees of European integration. In parallel to the further support to metrology, there is a whole set of "newcomer" countries (those that may currently have limited research activities or no NMI) who could contribute to solve the Metrology Dilemma through new capacity building and become new centres of excellence in particular new niche fields.

Mobility and Human Resource development

The option allows for tailor made mobility modules fully integrated and adapted to EMRP.

Global cooperation and position of Europe

Europe could speak with a single voice on metrology research to the world. Strategic partnerships at global level would become possible. Europe's position would be strengthened compared to other regions.

Support to regulation

To contribute to European regulation could be ensured through Art 169 through the influence of the Commission as co-sponsor.

Support to industry and economic growth

Co-ordination at European level may not lead to a worsening of local service provision. There have been worries that especially SMEs in Europe are not inclined to turn to other NMI in other countries for their queries. However, the service provision for industry is not in the core of the coordination activity (which is about R&D) and there is a potential gain through a better coordinated activity as local industries can get access to specialised European expertise.

European Commission

EUR 25155 - Interim Evaluation of the European Metrology Research Programme (EMRP).
Expert Panel Report

Luxembourg: Publications Office of the European Union

2012 - 76 pp. - 21.0 x 29.7 cm

ISBN 978-92-79-22681-6

doi 10.2777/58355

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This report summarises the findings of the independent expert panel which supported the Commission in carrying out an interim evaluation of the European Metrology Research Programme (EMRP) according to the decision of the European Parliament and the Council of 16 September 2009.

This evaluation covers progress towards the objectives of EMRP, as well as recommendations for the implementation and future of the EMRP. The report has been entirely prepared by the expert panel in its actual content.

The Commission will on the basis of this report communicate to the European Parliament and the Council the conclusions thereof, accompanied by its own observations as appropriate.

Studies and reports

