European Metrology Research Programme

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EMRP INTERIM REPORT

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Author: Duncan Jarvis (EURAMET EMRP Programme Manager)

Commission Project Officer: Wolfgang Wittke

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1 Executive summary

The 400 M€ European Metrology Research Programme (EMRP) was established in 2009 by the twenty-two participating countries and the European Union, utilising Article 169 (now Article 185) of the European Treaty. EURAMET - the European Association of National Metrology Institutes - is the body responsible for the implementation of the EMRP. The core activity of the EMRP consists of funding multi-partner transnational joint research projects to advance metrology and its applications. In view of the concentrated capacities in metrology, the core part of the EMRP is executed by National Metrology Institutes and Designated Institutes identified by the participating States. The joint research projects are supplemented by three researcher grant schemes.

The Programme runs an annual call and selection process. Nine projects were selected in 2009 covering metrology to support the security and sustainability of Europe's energy supply. 26 projects were selected in 2010 covering metrology for Industry and the Environment. The 2011 Call is covering Health, New Technologies and the SI system, 50 topics have been selected for the competition stage. Details of the projects, and the plans for future calls, are publicly available from the EURAMET website www.euramet.org. The processes are running smoothly and the national funding commitments to the programme are stable.

The EMRP is a good example of European Joint Programming - pooling national research efforts in order to make better use of Europe's precious public R&D resources to tackle common European challenges more effectively. The first stage of the call selects research areas where the stakeholder need is clear and the metrology community have the appropriate resources to make a significant impact. The second stage is a competition where the best proposals (in terms of scientific excellence and potential impact) are chosen by independent referees. The result is collaborative European projects where critical mass is brought to bear on clear objectives, with agreed project plans and enhanced stakeholder engagement. Some forty-four commercial organisations will participate in the twenty-six projects from the 2010 call, mostly self-funded. All the participants abide by the European level independent evaluation, clearly demonstrating the true "European Research Area" nature of the EMRP.

Before the start of the Programme ten areas were identified where enhanced scientific, management and financial integration of the European Metrology System was expected:

- Co-ordination and integration of NMI and national programmes
- Addressing Grand Challenges
- New Member State capacity building
- Open access to infrastructures
- Interaction with science community
- Modernisation of the metrology system
- Mobility and human resource development
- Global cooperation and position of Europe in the world
- Support to regulation
- Support to industry and economic growth

This report outlines progress in each area, success is greatest where the mechanisms were in place in the iMERA-Plus pilot projects for the programme, areas that rely on the mechanisms introduced in the A169 need longer to demonstrate impact.

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

Programme nearly half the total metrology research in the EMRP member organisations will be funded through the Programme. This provides a great focus for the scientists working in the National Metrology Institutes, as to see their work funded they need to engage in collaboration across Europe. In setting the indicative budgets, the EMRP Committee take a joint strategic view on priorities for metrology research across Europe. In 2010, following the decision on the SRTs, the Committee took the view that a greater need had been identified in the Industry TP than in the Environment TP and moved 3 M€ from Environment to Industry. In 2011 a similar decision was made to move 2.5 M€ from SI to Health. These decisions are not about individual projects but strategic direction, and feed through to national programmes and resource allocations within the NMIs. A joint strategic direction between the EMRP members is developed around the programme themes. The existence of the programme outline and the process for developing the scope for the calls are the embodiment of that joint strategy.

Above the EMRP Committee the national programme owners have aided integration by relinquishing control over a large proportion of their national programmes. The result of the Review Conference is in the hands of the independent referees. Only half the proposals will be funded. This can result in national priorities being frustrated if they have failed to convince the referees that their proposals are the best.

For this report, two surveys were conducted. One was among the EURAMET members to gather their view on the operation of the Programme and evidence of the impacts of the Programme in their countries. The other gathered the views of Programme participants on the practical arrangements for running the Programme processes. Both surveys reported strong support for the way the Programme was operating as well as some areas where improvements could be made. This report makes recommendations based on those findings.

Finally, the report highlights five projects from iMERA-Plus which demonstrate the variety in the type of project level impact to be expected from the programme:

1. A project focussed on collaboration to remove the last artefact - the kilogram - from the internationally agreed base units.
2. A project introducing metrology to the area of regenerative medicine - demonstrating that the need for metrology at the cutting edge is the same in the 21st century as it was in the 19th.
3. A project leading innovation - a new method for verifying the performance of laser trackers (devices used for precise measurement in manufacturing large objects such as aircraft wings) has been developed that moves the verification from a laboratory to the production environment and reduces the verification time from eight hours to one - greatly reducing downtime and leading to significant cost savings.
4. A project aimed at improving long distance measurement - which had a spin out in a commercial oxygen analyser.
5. A project responding to the Grand Challenge of sustainable energy - providing the tools for control of smart electricity grids.

2 Introduction

In the Decision establishing the EMRP, clause 25 of the pre-amble states - "The Commission should conduct an interim evaluation, assessing the quality and efficiency of the implementation of the EMRP and progress towards the objectives set….". This Interim Report is part of that evaluation, setting out the facts and figures for calls already held and the views of countries and individuals engaged with the Programme. It is based on the Annual Reports submitted to the Commission, a survey of participants in the programme (299 replies were received from 485 invitations) and a survey of EURAMET members (23 replies were received from the 35 members including 3 that do not participate in the EMRP).

Both surveys contained a summary question to gauge the overall satisfaction of the respondents with the Programme:

> The EURAMET members were asked - **"Having seen the EMRP in operation for 2 years, if you could return to the beginning and revise your National Commitment to the programme, would you change it?"** No member would have reduced their commitment, 9 (41 % of the participating countries) would have increased their commitment by 25 % or more. This indicates that the strategic aims of the Programme to bring greater coordination and integration of the national programmes across Europe are working well - with more states willing to devote a greater share of their national funding to the programme.
>
> The Programme participants were asked - **"Do the benefits from participating in a JRP outweigh the costs incurred?"** 86 % agreed. Of the 14 % that disagreed, three common comments were given. Over a third believed that the amount of time spent on JRP-coordination, administration and reporting was too high. Approximately a quarter believed that the unfunded cost of producing the JRP-Proposal (bid) was too high. The remaining comments came from JRP-Participants who were from smaller institutes or were unfunded JRP-Partners and believed that their level of funding was too low. While the programme is working well, the effort required for coordination compared to the minimal bureaucracy associated with national funding is a limitation.

These replies set the context for this report - a successful Programme seeking refinements to improve the impact it has in future calls. The structure of this report, and many of the questions asked, are defined in the agreement between EURAMET and the Commission. Section 3 concentrates on the facts and figures of the calls launched so far and the projects and researchers successful in those calls. Section 4 describes the call management process and assesses how effective it is. Section 5 concentrates on the funding process. Section 6 describes impact at the programme level while Section 7 gives examples of projects about to complete under iMERA-Plus (an ERA-Net Plus pilot for this programme) as an indication of the type of impact to be expected at project level. Throughout the report the results of both surveys are used to assess the programme processes and make recommendations on improvement for the remainder of the programme. The recommendations are summarised in Section 8.

Much more detail about the funded projects can be found at
http://www.euramet.org/index.php?id=emrp_calls_and_projects
and about the calls at
http://www.emrponline.eu/a169.html

3 The operation of the EMRP so far

3.1 Calls and budgets

The areas of the programme in broad terms (Targeted Programmes) to be opened in each year were decided by the EMRP Committee at the beginning of the programme, along with an indicative budget for each Targeted Programme. The areas, and current indicative budgets, are shown in Table 1. While the budget may be rebalanced between Targeted Programmes in any year (as happened in 2010 and 2011) it is not expected that the sequence of calls will be changed.

Year	Targeted Programme	Indicative budget - JRPs M€	Indicative budget - Researcher Grants M€	Total M€
2009	Energy	29.24	3.40	32.64
2010	Environment	38.38	4.46	42.84
	Metrology for Industry	44.18	5.14	49.32
2011	Health	28.00	3.26	31.26
	SI broader scope	23.00	2.67	25.67
	New Technologies	26.40	3.07	29.47
2012	Metrology for Industry	34.40	4.00	38.40
	SI broader scope	34.40	4.00	38.40
	Open Excellence	8.60	1.00	9.60
2013	Energy	47.30	5.50	52.80
	Environment	30.10	3.50	33.60
Overall totals		344.00	40.00	384.00

Table 1: Planned calls and budgets

3.2 Call 2009

EURAMET launched the first stage of the 2009 call (for "Potential Research Topics" or PRTs) requesting research ideas and needs addressing metrology underpinning the energy sector on 15 May 2009. The call closed 28 June 2009.

Of the 184 submissions received a total of 27 were superseded (those submitting before the deadline had the opportunity to make changes and resubmit up until the deadline, thus superseding their earlier submission), 2 were withdrawn by the submitter and a total of 12 failed to meet the eligibility criteria in that either no PRT document was attached, or a nonsense document had been attached. The 143 PRTs that passed the eligibility sift were reviewed by the EMRP sub-committee resulting in a consensus view to publish 16 topics at Stage 2. The topics selected are shown in Table 2. 19 % of the eligible PRTs came from outside the EURAMET membership.

The second stage dedicated call was launched 2 September and closed 2 November 2009. This call opened the 16 topics, each with a supporting document identifying the need or opportunity, the scientific objectives and likely impact.

SRT01	Metrology for biofuels
SRT02	Metrology for thermal efficiency of buildings
SRT03	Metrology for energy harvesting
SRT04	Metrology for energy saving in electronic devices and electrical machines
SRT05	Metrology for improved power plant efficiency
SRT06	Metrology for fuel cells
SRT07	Characterisation of energy gases
SRT08	Metrology for smart gas distribution grids
SRT09	Metrology for solid-state lighting
SRT10	Metrology for Liquefied Natural Gas (LNG)
SRT11	Metrology for new generation of nuclear power plants
SRT12	Metrology for fusion
SRT13	Metrology for solar cells and solar-thermal energy conversion
SRT14	Metrology for smart electrical grids
SRT15	Metrology for high-voltage direct current (HVDC)
SRT16	Metrology for wind energy conversion

Table 2: Selected Research Topics published in the 2009 call (Metrology for the Energy Sector)

Following the close of Stage 2 a total 16 proposals were received (one for each topic published, although more than one proposal per topic was possible). The Review Conference took place in a hotel in Berlin on 25 and 26 November 2009 where the referees scored the projects and agreed a Ranked List.

On 27 November, immediately following the Review Conference, the full EMRP Committee met and formally endorsed, without change, the recommendations of the independent referees with regard to the proposed JRPs and associated Researcher Excellence Grants. Although the referees deemed thirteen of the sixteen proposals of suitable quality for support budget restrictions were such that the top nine proposals were selected for funding. The remaining three proposals failed to meet the minimum of “3” from 5 mark in any one (or more) of the criteria. The actual budget cut line landed around two thirds of the way through the 4.17 M€ requested budget for this 9th ranked JRP (see Table 3 below). The EMRP Committee took into account the comments of the referees who identified (independently from the budget issue) that this 9th proposal (Biofuels) would benefit from tighter focus. Consequently the Committee concluded that modifications would be requested from the consortium to follow the recommendations of the referees and also to reduce the total cost of this JRP to around 3 M€.

In early 2010, the 9 projects selected from the 2009 Call were negotiated. The process started with face-to-face meetings between project officers from the EURAMET EMRP Management Support Unit (EMRP-MSU) and the individual JRP-Coordinators. The purpose was to convert the JRP-

Protocol as submitted at Stage 2 to form Annex 1 of the contract. An important initial task was to remove overlaps from the projects so that the total budgeted costs of the approved projects could be known and the EU funding rate for that call set. It was finally set at 46.1 %.

JRP Scoring BUDGET 29.24 M€

JRP	Name	Quality and efficiency	Relevance to EMRP objectives	Scientific/ technical excellence	Potential for impact	Total Score	Criteria Pass / Fail	Initial Rank	Final Rank	Total Cost	Cumulative Cost
JRP07	GAS	5.0	5.0	5.0	4.5	19.5	PASS	1	1	3,522,520	3,522,520
JRP03	HARVESTING	5.0	5.0	4.5	4.5	19.0	PASS	2	2	3,224,782	6,747,302
JRP10	LNG	5.0	5.0	4.5	4.5	19.0	PASS	2	2	2,628,051	9,375,353
JRP14	SMARTGRID	5.0	5.0	4.5	4.5	19.0	PASS	2	2	3,999,966	13,375,319
JRP09	LIGHTING	4.0	5.0	4.5	5.0	18.5	PASS	5	5	3,351,310	16,726,629
JRP05	POWERPLANT	4.5	5.0	4.0	4.5	18.0	PASS	6	6	3,591,896	20,318,525
JRP15	HVDC	4.5	5.0	4.0	4.0	17.5	PASS	7	7	2,877,642	23,196,167
JRP11	NUCLEAR	4.5	4.5	4.0	4.0	17.0	PASS	8	8	3,642,698	26,838,865
~~JRP01~~	~~BIOFUELS~~	~~4.5~~	~~4.5~~	~~4.0~~	~~3.5~~	~~16.5~~	~~PASS~~	~~9~~	~~9~~	~~4,171,196~~	~~31,010,061~~
JRP12	FUSION	4.0	4.5	4.0	3.5	16.0	PASS	10	10	3,948,690	34,958,751
JRP04	ELECTRONIC	3.5	5.0	3.0	4.0	15.5	PASS	11	11	3,609,973	38,568,724
JRP06	FUELCELLS	4.0	4.5	3.0	3.5	15.0	PASS	12	12	3,417,685	41,986,409
JRP13	SOLAR	3.0	4.0	4.0	3.0	14.0	PASS	13	13	3,479,573	45,465,982
JRP16	WIND	3.0	4.0	2.5	4.0	13.5	FAIL	99	99	3,551,179	49,017,161
JRP02	BUILDINGS	2.5	4.5	2.5	3.0	12.5	FAIL	99	99	3,067,301	52,084,462
JRP08	GASGRID	3.0	2.0	3.0	2.5	10.5	FAIL	99	99	2,289,725	54,374,187

~~XXXX~~ JRP cut by budget line

Table 3: Ranked List from the 2009 Review Conference

Full names of the funded projects following contract negotiations, are given in Table 4.

Number	Short Name	Title
ENG01	GAS	Characterisation of Energy Gases
ENG02	Harvesting	Metrology for Energy Harvesting
ENG03	LNG	Metrology for Liquefied Natural Gas
ENG04	SmartGrid	Metrology for Smart Electrical Grids
ENG05	Lighting	Metrology for Solid State Lighting
ENG06	Powerplants	Metrology for Improved Power Plant Efficiency
ENG07	HVDC	Metrology for High Voltage Direct Current
ENG08	MetroFission	Metrology for New Generation Nuclear Power Plants
ENG09	Biofuels	Metrology for Biofuels

Table 4: Titles of funded projects from the 2009 Call

Researcher Grants associated with these projects were selected both at Stage 2 and at a Stage 3 Call in April 2010. Further opportunities were also available in the Stage 3 Call in April 2011. The Researcher Grants contracted in association with these projects are shown in Table 5. (Note that the table includes both Researcher Excellence Grants (REGs) and Researcher Mobility Grants (RMGs)). All selected Researcher Grants could have been funded, at least one withdrew after selection, and others are still being negotiated.

RG Ref	JRP number	JRP Name	Researcher	Home /Employing	Guestworking
ENG01-REG1	ENG01	GAS	Simone Corbellini	POLITO DELEN	N/A
ENG03-REG1	ENG03	LNG	Markus Richter	RUB	N/A
ENG04-REG1	ENG04	SmartGrid	Angelos Bouchouras	AUTH	N/A
ENG04-REG2	ENG04	SmartGrid	Alberto Venturi	STRAT	N/A
ENG05-REG1	ENG05	Lighting	Daren Lock	SURREY	N/A
ENG06-REG1	ENG06	Powerplants	Boris Wilthan	TUG	PTB
ENG07-REG1	ENG07	HVDC	Vladimir Ermel	TUBS	N/A
ENG07-RMG1	ENG07	HVDC	Ahmet Merev	TUBITAK UME	MIKES
ENG08-REG1	ENG08	MetroFission	Michele Scervini	UCAM	N/A
ENG08-RMG1	ENG08	MetroFission	Matej Krivosik	SMU	CEA
ENG08-RMG2	ENG08	MetroFission	Andrei Antohe	IFIN-HH	ENEA
ENG09-REG1	ENG09	Biofuels	Dzimitry Zaitsau	Uni Rostock	N/A
ENG09-RMG1	ENG09	Biofuels	Daniela Stoica	LNE	NPL
ENG09-RMG2	ENG09	Biofuels	Ronald Pagel	PTB	LNE

Table 5: Researcher Grants selected and funded in association with the 2009 Energy Call

3.3 Call 2010

EURAMET launched the first stage of the 2010 call requesting research ideas and needs addressing metrology for Industry and Environment on 12 February 2010. The call closed 28 March 2010.

Of the 278 submissions received a total of 49 were superseded, and a total of 6 failed to meet the eligibility criteria through not supplying enough information for the idea to be considered. The 223 eligible submissions may seem a small increase on the 143 received in 2009 considering the budget had increased nearly three fold, but in 2009 many submissions were similar topics submitted by multiple authors. In 2010 the templates were changed to allow “co-authors” to be identified on the forms and encouraged interest groups to submit one joint entry rather than multiple similar entries. This saved significant effort in processing the submissions. There were a total of 1031 named authors, 37 % of which came from outside EURAMET. The 223 PRTs that passed the eligibility sift were reviewed by the EMRP sub-committee resulting in a consensus view to publish 28 topics for Industry and 18 for Environment at Stage 2. At the same time, having regard for the number of topics that had been defined for each part of the call, the sub-committee decided to recommend a rebalancing of the budget between the TPs, moving from an equal split to a ratio of 54:46 for Industry : Environment. This was subsequently approved by the full EMRP committee. The topics selected are shown in Table 6.

SRT01i	Traceable quantitative surface chemical analysis for industrial applications
SRT02i	Multi-sensor data fusion in dimensional metrology
SRT03i	Dynamic mechanical properties and long-term deformation behaviour of viscous materials
SRT04i	Thermal design and time-dependent dimensional drift behaviour of sensors, materials and structures
SRT05i	Dimensional characterisation of functional structured surfaces
SRT06i	Optical and tactile metrology for absolute form characterisation
SRT07i	New generation of frequency standards for industry
SRT08i	Radio frequency metrology for wireless networks in industrial environments
SRT09i	Metrology for Ultrafast Electronics and High-Speed Communications
SRT10i	Metrology for high-speed microelectronics
SRT11i	Metrology for advanced industrial magnetics
SRT12i	Electromagnetic characterization of materials for industrial applications up to microwave frequencies
SRT13i	Ionising Radiation Metrology for Metallurgical Industry
SRT14i	Vacuum metrology for production environments
SRT15i	Metrology of Small Structures for the Manufacturing of Electronic and Optical Devices
SRT16i	Metrology to Assess the Durability and Function of Engineered Surfaces
SRT17i	Optical Sensing of Large Objects in Production Engineering
SRT18i	Metrology for the manufacturing of thin films
SRT19i	Flow metrology for industrial process control
SRT20i	Traceable Dynamic Measurement of Mechanical Quantities
SRT21i	High Pressure Metrology for Industrial Applications
SRT22i	Weighing instruments for traffic application
SRT23i	Force and Torque for industrial applications
SRT24i	Optical Metrology for Appearance of Advanced Functional Surfaces
SRT25i	Metrology for Imaging Photometry and UV Radiometry for Industrial applications
SRT26i	Metrology for Industrial Quantum Communication Technologies
SRT27i	Thermal Conductivity metrology for High-Temperature Insulation
SRT28i	High Temperature Metrology for Industrial Applications (>1000 °C)
SRT01e	Traceability for global monitoring of key reactive and short-lived compounds in the atmosphere
SRT02e	Metrology for Pressure, Temperature, Humidity and Airspeed in the Atmosphere
SRT03e	Metrology for carbon capture and storage
SRT04e	Metrology to Support Emissions Trading Schemes
SRT05e	Traceability for Green House Gases
SRT06e	Emerging requirements for measuring pollutants from automotive exhaust emissions
SRT07e	Metrology for oceanic salinity and acidification
SRT08e	Metrology for oceanic biodiversity monitoring as a climate change indicator
SRT09e	Traceability for Surface Spectral Solar Ultraviolet Radiation
SRT10e	Measurement and characterisation of engineered nanoparticles in the environment
SRT11e	Metrology for particles and aerosols in air
SRT12e	Traceable measurements for monitoring critical pollutants under the "European Water Framework Directive (WFD-2000/60/EC)"
SRT13e	Metrology for emerging pollutants and new tools in aquatic environments
SRT14e	Metrology for chemical pollutants in air
SRT15e	Metrology for Nuclear Facilities Discharges
SRT16e	Spectral reference data for atmospheric monitoring
SRT17e	Traceable Radiometry for Remote Measurement of Climate Parameters
SRT18e	Metrology for radioactive waste management

Table 6: Selected Research Topics published in the 2010 call (Metrology for Industry & Environment)

The second stage dedicated call for joint research projects and associated REGs was launched on 21 June and closed 11 October 2010. This call opened the 46 topics, each with a supporting document identifying the need or opportunity, the scientific objectives and likely impact.

Following the close of Stage 2 a total of 45 proposals were received. The Review Conference took place in a hotel in Budapest from 22 to 25 November 2010 where the referees scored the projects and agreed a Ranked List.

On 28 November, immediately following the Review Conference, the full EMRP Committee met and formally endorsed, without change, the recommendations of the independent referees with regard to the proposed JRPs and associated Researcher Excellence Grants. Although the referees deemed all the 17 Environment proposals and 25 of the 28 Industry proposals of suitable quality for support (the remaining three proposals failed to meet the minimum of “3” from 5 mark in one (or more) of the criteria), budget restrictions were such that a funding line had to be drawn in each list.

Neither the referees nor proposers had identified any significant duplication of work between proposals likely to be funded, and so there were no changes to be made to the size of individual projects and the choice faced by the EMRP Committee was merely where to draw the line in each list.

The Ranked Lists are shown in Table 7and Table 8. The predefined budget would have resulted in funding the projects above the tan shading in each list, but the Programme Manager presented the Committee with an overview of the feedback from the referees on the projects around the budget line and with a more sophisticated range of options of what the total and percentage EU contribution to the projects would be if the projects in the tan area were also funded. Debate in the Committee did not just concentrate on the finances but also considered the detailed referee comments about each project, but the final decision was to add the two projects in the tan area from the Industry TP and not to add the projects in the Environment TP, thus funding the top 9 projects in Environment and the top 17 in Industry. This was the solution that maximised both the total EU funding to the projects and the percentage EU contribution at 45.6 %.

Contract negotiations for these projects started in January 2011 and are ongoing at the time of writing.

JRP	Name	Scientific and/or technical excellence	Relevance to EMRP objectives	Potential for impact	Quality and efficiency of implementation	Total Score	Criteria Pass / Fail	Initial Rank	Final Rank	Total Cost	Cumulative Cost
JRP28i	HiTeMS	5.0	5.0	5.0	4.5	19.5	PASS	1	1	3 245 930	3 245 930
JRP12i	EMINDA	4.5	5.0	5.0	4.0	18.5	PASS	2	2	2 786 003	6 031 933
JRP21i	High pressure metrology	5.0	4.5	4.5	4.5	18.5	PASS	2	3	2 080 001	8 111 934
JRP13i	MetroMetal	4.5	5.0	4.5	4.5	18.5	PASS	2	4	3 009 804	11 121 737
JRP03i	MEPROVISC	4.5	4.5	4.5	4.5	18.0	PASS	5	5	2 267 271	13 389 008
JRP26i	MIQC	5.0	4.5	4.0	4.5	18.0	PASS	5	6	2 859 718	16 248 726
JRP18i	Thin Films	4.5	4.5	4.5	4.0	17.5	PASS	7	7	3 023 847	19 272 573
JRP11i	MetMags	4.5	4.5	4.0	4.5	17.5	PASS	7	8	2 696 207	21 968 780
JRP20i	Dynamic Measurement	4.0	4.5	5.0	3.5	17.0	PASS	9	9	3 584 374	25 553 153
JRP06i	Form metrology	4.5	4.5	4.5	3.5	17.0	PASS	9	10	2 859 502	28 412 655
JRP16i	MADES	4.5	4.0	4.5	4.0	17.0	PASS	9	11	2 690 050	31 102 705
JRP14i	Vacuum Metrology	4.5	4.5	4.0	4.0	17.0	PASS	9	12	2 785 906	33 888 611
JRP04i	Thermal design and dimensional d	4.0	4.5	4.0	4.0	16.5	PASS	13	13	2 711 641	36 600 252
JRP07i	Frequency	4.5	4.5	3.5	4.0	16.5	PASS	13	14	3 161 400	39 761 651
JRP01i	SurfChem	4.0	4.5	4.0	3.5	16.0	PASS	15	15	3 141 307	42 902 958
JRP09i	Ultrafast Electronics	4.0	4.5	4.0	3.0	15.5	PASS	16	16	2 610 243	45 513 201
JRP15i	Scatterometry	4.0	3.0	4.0	4.5	15.5	PASS	16	17	3 271 586	48 784 787
JRP10i	MET4TRONICS	3.5	4.5	4.0	3.5	15.5	PASS	16	18	3 652 544	52 437 332
JRP02i	Multi-Sensor uCMM	4.0	4.0	3.5	4.0	15.5	PASS	16	19	3 550 014	55 987 346
JRP27i	Thermal Conductivity	4.0	4.0	3.5	4.0	15.5	PASS	16	20	2 493 361	58 480 708
JRP24i	APPEARANCE	4.5	4.0	3.5	3.0	15.0	PASS	21	21	2 488 763	60 969 471
JRP19i	Flow Metrology	4.0	4.0	3.5	3.5	15.0	PASS	21	22	3 872 014	64 841 484
JRP17i	OptiSLOPE	3.0	4.0	3.0	4.0	14.0	PASS	23	23	3 327 041	68 168 525
JRP05i	FUNCSTAND	3.5	3.5	3.0	3.5	13.5	PASS	24	24	2 823 499	70 992 024
JRP25i	Imaging Photometry	3.0	3.5	3.5	3.0	13.0	PASS	25	25	3 238 807	74 230 831
JRP08i	Wireless networks in industry	3.0	3.0	3.0	2.5	11.5	FAIL	99	99	2 605 832	76 836 663
JRP23i	Force and torque metrology	3.0	3.0	2.0	2.0	10.0	FAIL	99	99	3 336 349	80 173 013
JRP22i	TRAFFIC WEIGHING	3.0	2.0	2.0	2.5	9.5	FAIL	99	99	2 274 077	82 447 089

Table 7: JRP scores from 2010 Review Conference (Industry Ranked List)

JRP	Name	Scientific and/or technical excellence	Relevance to EMRP objectives	Potential for impact	Quality and efficiency of implementation	Total Score	Science + Impact	Impact	Criteria Pass / Fail	Initial Rank	Final Rank	Total Cost	Cumulative Cost
JRP14e	MACPoll	5.0	4.5	5.0	4.0	18.5	10.0	5.0	PASS	1	1	3 746 912	3 746 912
JRP06e	Automotive particulate emissions	5.0	4.5	4.0	4.5	18.0	9.0	4.0	PASS	2	2	3 967 943	7 714 855
JRP09e	solarUV	5.0	5.0	4.0	4.0	18.0	9.0	4.0	PASS	2	3	3 970 888	11 685 743
JRP17e	EMCEOC	4.5	4.5	4.5	4.0	17.5	9.0	4.5	PASS	4	4	4 481 570	16 167 313
JRP07e	Ocean Metrology	4.5	5.0	4.0	4.0	17.5	8.5	4.0	PASS	4	5	4 404 866	20 572 179
JRP16e	EUMETRISPEC	4.0	4.5	5.0	3.5	17.0	9.0	5.0	PASS	6	6	4 040 446	24 612 625
JRP02e	METEOMET	4.5	4.0	4.5	4.0	17.0	9.0	4.5	PASS	6	7	4 413 683	29 026 308
JRP12e	WFDtraceability	4.5	5.0	4.0	3.5	17.0	8.5	4.0	PASS	6	8	4 498 507	33 524 815
JRP18e	MetroRWM	4.0	5.0	4.5	3.5	17.0	8.5	4.5	PASS	6	9	4 023 797	37 548 612
JRP08e	Oceanic Biodiversity	4.0	4.5	4.5	3.5	16.5	8.5	4.5	PASS	10	10	3 462 284	41 010 896
JRP04e	METS	4.0	4.5	4.0	4.0	16.5	8.0	4.0	PASS	10	11	4 222 377	45 233 274
JRP13e	EMERGENT	4.0	4.5	3.5	4.5	16.5	7.5	3.5	PASS	10	12	3 878 706	49 111 980
JRP11e	Ambient aerosols	4.0	4.0	4.0	4.0	16.0	8.0	4.0	PASS	13	13	4 490 291	53 602 271
JRP03e	CCS	3.5	4.0	4.0	4.0	15.5	7.5	4.0	PASS	14	14	4 150 648	57 752 919
JRP01e	Short-Lived Climate Gases	4.0	3.0	4.0	3.5	14.5	8.0	4.0	PASS	15	15	4 090 779	61 843 698
JRP05e	GreenTrac	4.0	3.0	3.0	3.0	13.0	7.0	3.0	PASS	16	16	3 837 036	65 680 734
JRP10e	ENP-ENV	3.0	3.0	3.0	3.5	12.5	6.0	3.0	PASS	17	17	4 111 298	69 792 031

Table 8: JRP scores from 2010 Review Conference (Environment Ranked List)

The full names of the selected projects are shown in Table 9, and the Researcher Grants selected in association with that call are shown in Table 10.

Number	Short Name	Title
ENV01	MACPoll	Metrology for chemical pollutants in air
ENV02	PartEmission	Emerging requirements for measuring pollutants from automotive exhaust emissions
ENV03	SolarUV	Traceability for Surface Spectral Solar Ultraviolet Radiation
ENV04	EMCEOC	Traceable Radiometry for Remote Measurement of Climate Parameters
ENV05	Ocean	Metrology for oceanic salinity and acidification
ENV06	EUMETRISPEC	Spectral reference data for atmospheric monitoring
ENV07	METEOMET	Metrology for Pressure, Temperature, Humidity and Airspeed in the Atmosphere
ENV08	WFD	Traceable measurements for monitoring critical pollutants under the "European Water Framework Directive (WFD-2000/60/EC)"
ENV09	MetroRWM	Metrology for radioactive waste management
IND01	HITEMS	High Temperature Metrology for Industrial Applications (>1000 °C)
IND02	EMINDA	Electromagnetic characterization of materials for industrial applications up to microwave frequencies
IND03	HighPRES	High Pressure Metrology for Industrial Applications
IND04	MetroMetal	Ionizing Radiation Metrology for Metallurgical Industry
IND05	MEPROVISC	Dynamic mechanical properties and long-term deformation behaviour of viscous materials
IND06	MIQC	Metrology for Industrial Quantum Communication Technologies
IND07	Thin Films	Metrology for the manufacturing of thin films
IND08	MetMags	Metrology for advanced industrial magnetics
IND09	Dynamic	Traceable Dynamic Measurement of Mechanical Quantities
IND10	Form	Optical and tactile metrology for absolute form characterization
IND11	MADES	Metrology to Assess the Durability and Function of Engineered Surfaces
IND12	Vacuum	Vacuum metrology for production environments
IND13	T3D	Thermal design and time-dependent dimensional drift behaviour of sensors, materials and structures
IND14	Frequency	New generation of frequency standards for industry
IND15	SurfChem	Traceable quantitative surface chemical analysis for industrial applications
IND16	Ultrafast	Metrology for Ultrafast Electronics and High-Speed Communications
IND17	Scatterometry	Metrology of Small Structures for the Manufacturing of Electronic and Optical Devices

Table 9: Titles of selected projects from the 2010 Call

RG Ref	JRP number	JRP Name	Researcher	Home /Employing	Guestworking
ENV01-REG1	ENV01	MACPoll	Manuel Aleixandre	CSIC	N/A
ENV01-REG2	ENV01	MACPoll	Olavi Vaittinen	UH	VSL
ENV03-REG1	ENV03	SolarUV	Mario Blumthaler	IMU	N/A
ENV05-REG1	ENV05	Ocean	Robert Clough	UoP	N/A
ENV07-REG1	ENV07	METEOMET	Elisa Vuillermoz	EV-K2-CNR	N/A
ENV09-REG1	ENV09	MetroRWM	Lukas Skala	ENVINET	N/A
IND01-REG1	IND01	HITEMS	Marko Seifert	FhG	N/A
IND02-REG1	IND02	EMINDA	Jens Niegemann	ETHZ	N/A
IND02-REG2	IND02	EMINDA	Stephen Hanham	IC	N/A
IND05-REG1	IND05	MEPROVISC	Norbert Schwarzer	Norbert Schwarzer	NPL
IND06-REG1	IND06	MIQC	Damien Stucki	IDQ	NPL
IND07-REG1	IND07	Thin Films	Alfons Weber	HZB	N/A
IND07-REG2	IND07	Thin Films	Peter Petrik	FhG	N/A
IND07-REG3	IND07	Thin Films	Jong-Soo Kim	IC	N/A
IND08-REG1	IND08	MetMags	Elisa De Ranieri	HEL	N/A
IND10-REG1	IND10	Form	Eugenio Garbusi	ITO	N/A
IND10-REG2	IND10	Form	Ton Moers	Xpress	N/A
IND12-REG1	IND12	Vacuum	Vincenzo Ierardi	UNIGE	IMT
IND13-REG1	IND13	T3D	Marc Schalles	TU-IL	N/A
IND14-REG1	IND14	Frequency	Nikolaus Metzger	USTAN	N/A
IND15-REG1	IND15	SurfChem	Elin Larsson	Chalmers	N/A
IND17-REG1	IND17	Scatterometry	Sven Burger	JCM	N/A
IND17-REG2	IND17	Scatterometry	Toni Saastamoinen	UEF	N/A
IND17-REG3	IND17	Scatterometry	Omar el Gawhary	TU Delft	N/A

Table 10: Researcher Grants selected in association with the 2010 Industry and Environment Call

Stage 3 of the 2010 Call was opened on 31 March 2011. It closed in early May and the applications are now undergoing eligibility checks and evaluation.

3.4 Call 2011

EURAMET launched the first stage of the 2011 call requesting research ideas and needs addressing metrology for Health, SI, and New Technologies on 4 February 2011. The call closed 20 March 2010. Of the 206 submissions received a total of 53 were superseded, none failed to meet the eligibility criteria. Of the 1069 authors, 29 % were from outside the EURAMET membership. At the time of writing, 153 PRTs have been prioritised by the EMRP sub-committee, provisional titles for 50 SRTs are shown in Table 11.

SRT-h01	Metrology for monitoring infectious diseases, antimicrobial resistance, and harmful micro-organisms
SRT-h02	Advanced cell imaging for neurodegenerative disease
SRT-h03	Next generation metrology for targeted gene delivery
SRT-h04	Metrology at the cellular and DNA level
SRT-h05	Metrology for neurodegenerative disorders
SRT-h06	Metrology for the characterisation of biomolecular interfaces for diagnostic devices
SRT-h07	Traceability for health-related biomarkers
SRT-h08	Metrology for chemical and functional imaging of skin and tissue
SRT-h09	Metrology for next-generation safety standards and equipment in MRI
SRT-h10	Metrology for breath analysis
SRT-h11	Metrology for a universal ear simulator and the perception of non-audible sound
SRT-h12	Metrology for therapeutic ultrasound
SRT-h13	Metrology for molecular radiotherapy
SRT-h14	Metrology for radiotherapy using complex radiation fields
SRT-h15	Metrology for biomolecular origin of disease
SRT-h16	Diagnostics and therapy using magnetic nanoparticles
SRT-h17	Metrology for metalloproteins
SRT-h18	Metrology for drug delivery
SRT-h19	Continuous glucose measurement methods and systems for medical surveillance
SRT-h20	Metrological characterisation of micro-vesicles from body fluids as non-invasive diagnostic biomarkers
SRT-n01	Novel mathematical and statistical approaches to uncertainty evaluation
SRT-n02	Traceability for computationally-intensive metrology
SRT-n03	Metrological 3D characterisation of nanostructures
SRT-n04	Graphene metrology
SRT-n05	Metrology for Raman spectroscopy
SRT-n06	Traceable characterisation of nanostructured devices
SRT-n07	Metrology with/for NEMS
SRT-n08	Metrology for spintronic circuits and devices
SRT-n09	Detection and characterisation of quantum phase slip for development of nanoscale quantum circuits
SRT-n10	Metrology for airborne manufactured and engineered nano-objects
SRT-n11	Chemical and optical characterisation of nanoparticles (characterisation beyond geometry)
SRT-n12	Traceable measurement of mechanical properties of nano-objects
SRT-n13	Metrology of electro-thermal coupling for new functional materials technology
SRT-n14	Metrology for integrated photonic devices and new photonic materials
SRT-n15	Microwave and terahertz metrology for homeland security
SRT-n16	Chemical metrology for the accurate identification and detection of hazardous and hidden materials
SRT-n17	Ionising radiation metrology for homeland security
SRT-s01	A quantum standard for sampled electrical measurements
SRT-s02	Quantum ampere: Realisation of the new SI ampere
SRT-s03	Automated impedance metrology extending the quantum toolbox for electricity
SRT-s04	Biologically weighted quantities in radiotherapy
SRT-s05	Traceability of sub-nm length measurements
SRT-s06	Realisation of the awaited definition of the kilogram - resolving the discrepancies
SRT-s07	Developing a practical means of disseminating the new kilogram
SRT-s08	Primary standards for challenging elements
SRT-s09	Traceability for single-photon sources
SRT-s10	High-accuracy optical clocks with trapped ions
SRT-s11	Accurate time/frequency comparison and dissemination through optical telecommunication networks
SRT-s12	Novel techniques for traceable temperature dissemination
SRT-s13	Implementing the new Kelvin

Table 11: Preliminary titles for Selected Research Topics in the 2011 call.

4 Call management

4.1 Preparation for a call

The process for defining the individual areas is shown in Figure 1. It starts with the appointment of a "Guardian" for the Targeted Programme from the EMRP Committee. The Guardian consults widely with stakeholders and refines the input from the relevant parts of the EMRP Outline 2008[1] into the "scope" document that defines the area for which the call for Potential Research Topics is focussed at Stage 1.

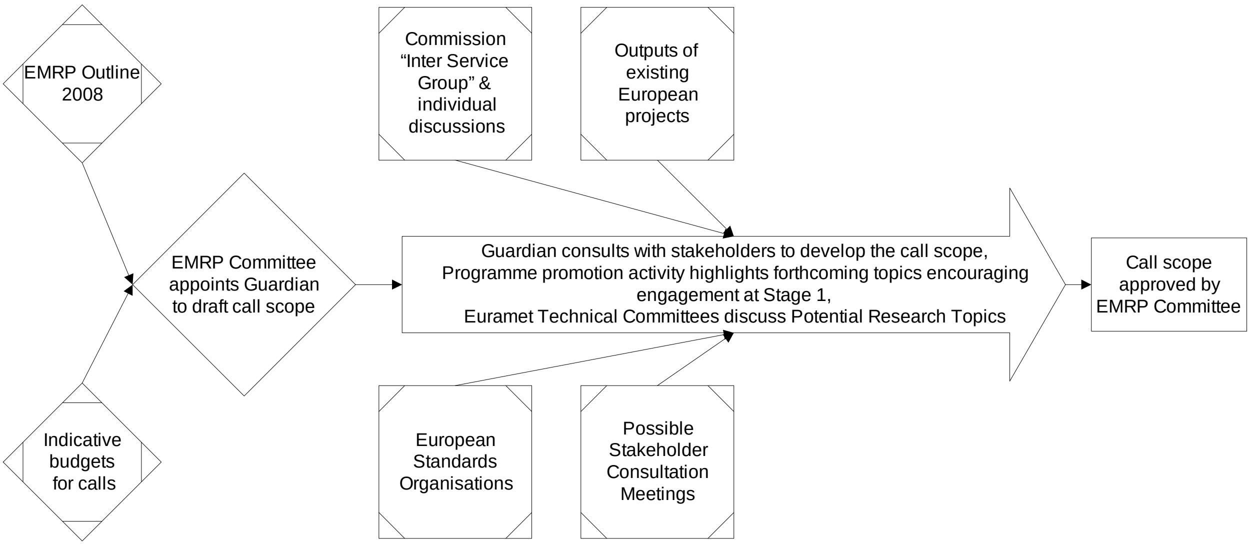


Figure 1: Process for defining the area of the programme to be opened

The scope documents for past calls can be found on www.emrponline.eu in the archived call pages.

[1] The outline was the result of a series of stakeholder and partner workshops held under the iMERA project and can be found at http://www.euramet.org/index.php?id=documents

4.2 Stage 1 process (identifying metrological challenges)

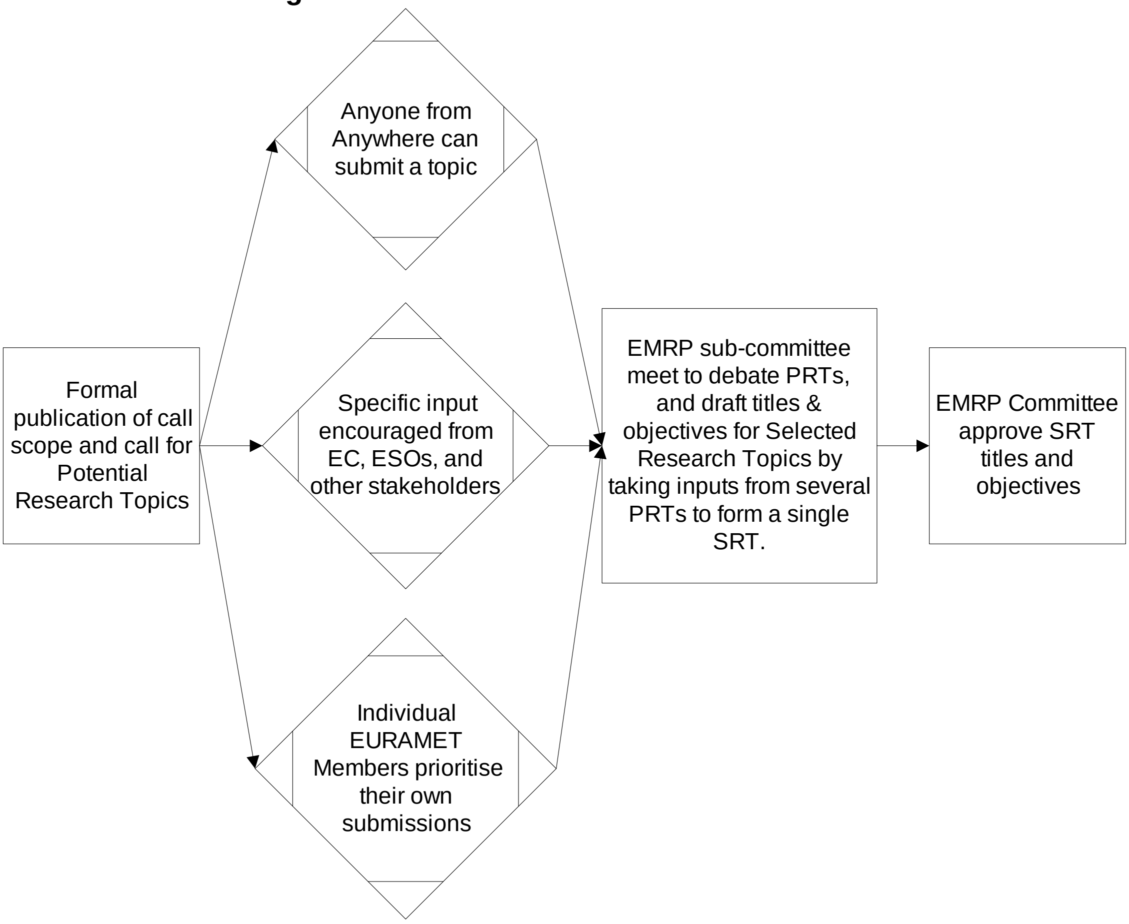
The first part of a call is formally announced in early February, covering the launch of Stage 1 “Call for potential metrology research topics (PRTs)” and advance notification of the launch of Stage 2 “Call for proposals for Joint Research Projects (JRPs) and associated applications for Researcher Excellence Grants (REGs)”. It is announced through three national newspapers in three EMRP participating countries, at least one international journal, as well as on the EURAMET website and through various other electronic media. Stage 1 of the call usually closes in late March.

The aim of Stage 1 is to identify challenges and problems and provide ideas to help the EMRP Committee best prioritise the most important topics to address and make best use of the resources available in the NMI and DI community. This stage is open to any person or organisation from anywhere. The process is web based and provides a simple WORD template to ensure ideas are expressed in an appropriate way. Proposers provide administrative information online, and upload their idea as a WORD file. All submissions are automatically acknowledged by e-mail. The process for Stage 1 of the call is illustrated in Figure 2.

The online web page requires proposers to self identify the most appropriate classification against a list, with the option of “other” for cross cutting topics. The classification is only used to make it more likely that similar topics will be reviewed together. The templates allow “co-authors” to be identified on the forms and encourage interest groups to submit one joint entry rather than multiple similar entries.

Submissions undergo a simple eligibility check to ensure that they can be prioritised (e.g. submission in English, all required sections of the form complete etc) and to remove any submissions that were superseded by the submitters. An Excel workbook is prepared for the EMRP sub-committee with instructions, statistical data and collated information on all of the submissions, and pre-programmed cells to enable marking and comments to be captured. The subcommittee initially work in pairs, each pair responsible for the initial review of PRTs within two or three classifications, thus sharing the workload. Each EMRP sub-committee member is provided with an individual Excel workbook to capture initial impressions and comments. These individual workbooks are then sent back to the EMRP-MSU where the inputs are collated into a single consolidated Excel workbook. This consolidated workbook is then redistributed such that all members of the EMRP sub-committee can see all initial PRT comments, i.e. their own and every other members comments in preparation for the sub-committee meeting. At this stage the review is widened with EMRP sub-committee members free to review all PRTs and prepare further comments. This process culminates in a meeting of the sub-committee where the titles and objectives for the Selected Research Topics are drafted for subsequent approval by the full EMRP Committee. The key criteria in the selection of the topics is alignment with the scope of the call, that the stakeholder need is clearly identified and supported, and that relevant expertise and facilities exist within EURAMET to address those needs.

Figure 2: Process for stage 1 of a call



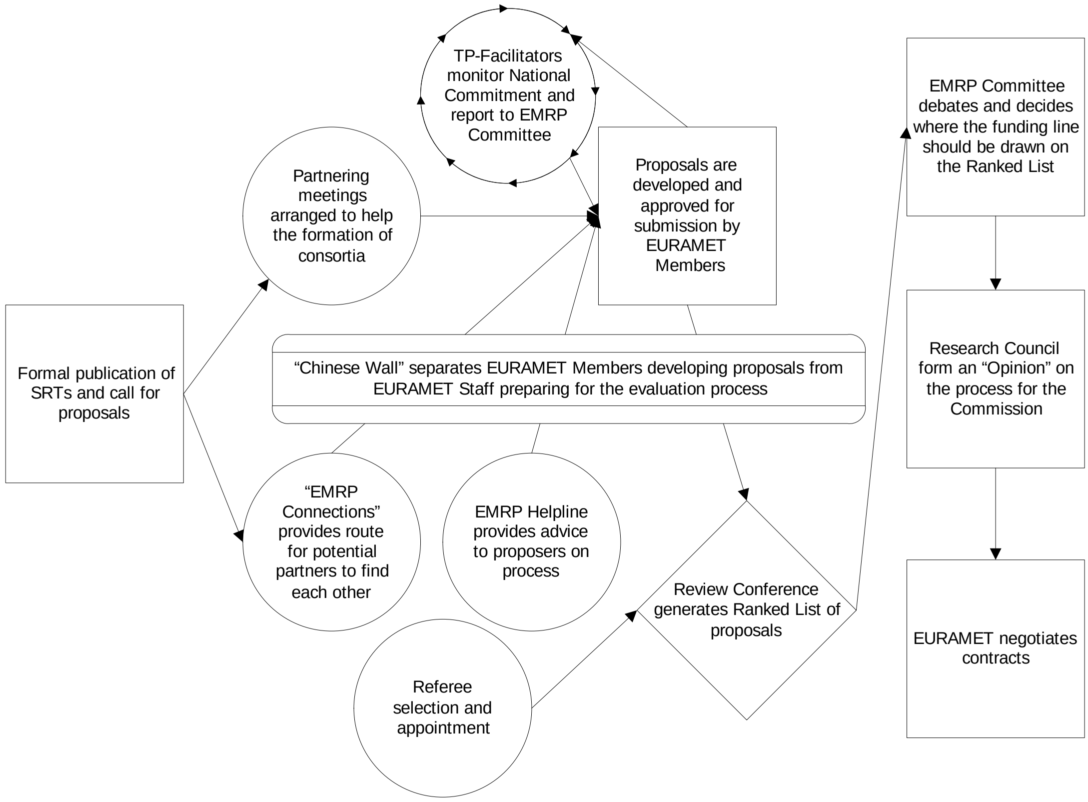
Following the full EMRP Committee meeting a list of the titles of the SRTs is placed on www.emrponline.eu along with information on partnering meetings to be held immmediately following the launch of Stage 2. The first drafts of the “Supporting Documents” are prepared by the EMRP-MSU, a short document for each topic describing the background, objectives and potential impact. The information and much of the text for the supporting documents is drawn from the relevant PRTs. These drafts are then reviewed by the EMRP sub-committee and iterated until deemed acceptable.

When considering the above process it would be rather misleading to imagine the process as one of prioritising one PRT over another. Rather it is a case of reviewing all PRTs in a given area, establishing a list of all of the needs, scientific and technological objectives and potential impacts expressed, and then identifying which of those ideas could be addressed most effectively by the metrology research community. Thus in each area all of the objectives from all relevant PRTs are assembled, and prioritised. The process is better thought of as a prioritisation of ideas rather than prioritisation of particular PRTs, although the “genealogy” of all Stage 2 topics is carefully captured ensuring the traceability of each of the Stage 2 topics to its “parent” contributing PRTs. This approach ensures efforts can be focused most appropriately, but makes the preparation of the supporting documents challenging (as it is not simply a case of choosing PRT X over PRT Y and then editing the text of PRT X). The topics are assembled not only to bring the best resources from EURAMET to bear on the identified needs, but also to promote closer working between different EURAMET members and across technical disciplines by combining objectives in single topics that can only be addressed through collaboration.

4.3 Stage 2 process (selecting Joint Research Projects)

The second stage dedicated call for joint research projects and associated REGs usually launches in late June and closes in early October. This call opens the Selected Research Topics, each with a supporting document identifying the need or opportunity, the scientific objectives and likely impact. The overall process at Stage 2 of the Call is illustrated in Figure 3.

Figure 3: Process for stage 2 of a call



4.3.1 Referees

In parallel with the call the EMRP-MSU and the EMRP Chair and Deputy Chair establish the list of independent referees. In accordance with the Council Decision all referees are drawn from the FP7 expert database. The primary and overriding criteria for the selection of the referees is scientific and technical competence (and their independence from the proposers). Within that constraint the best balance of gender, nationality, background etc is sought. This process involves the establishment of a larger than needed initial pool of competent referees from which availability is checked, and then, provided there is choice, following a defined set of criteria aimed at achieving the best balance.

In practice, expertise is established with an initial key word search of the FP7 database followed by a detailed review of CVs. It is assumed that many if not most NMIs and DIs in Europe would participate in the programme so no referees are targeted from these organisations. For all referees a more detailed check for conflict of interest is made at each stage of the process to ensure no referees are drawn from organisations involved in the submission of proposals. Those experts (numbering about 200) passing the sift, are entered into the "pool". The experts in the pool are then contacted to establish their willingness to act as referees for EURAMET, their availability and their expectation of being independent from any proposal. The terms and conditions offered in terms of expenses etc closely follow those used by the Commission for FP7. Potential referees in the "pool" who indicate they could be available are provided with the relevant supporting documents and asked to "self check" their suitability. They respond by e-mail indicating one of three possibilities for each SRT that the paper based review had indicated they would be suitable for:

- Able to read a proposal likely to be received against the SRT as a specialist
- Able to read a proposal likely to be received against the SRT as a generalist
- Unable to read a proposal likely to be received against the SRT

This allows the establishment of the boundary conditions of available and competent referees with a very high degree of confidence that there will be "no surprises". With at least three referees allocated to each proposal and a maximum of four proposals allocated to each referee, the aim is to have as many referees as SRTs. In selecting the referees from the pool the aim is:

- At least 2 specialists and 1 generalist for each SRT
- Gender: at least 10 % women (obviously we would prefer 50 %, however this figure is totally unachievable in our field)
- Employment: industry ~ 50 %, "other" ~ 50 %
- Countries; outside Europe (1-3), of the remainder EU15 ~60 %, EU12 ~40 %, with as many countries represented as possible, with a limit of 3 referees for any one country
- Some redundancy is built in the process in case the EMRP-MSU checks or declaration by the referees identify real or potential conflicts of interest for referees, requiring them to drop out ahead of the evaluation.

The final list of referees is published on www.euramet.org in December.

4.3.2 Stage 2 Eligibility and Evaluation

Following the close of Stage 2 all proposals undergo an eligibility check by the EMRP-MSU against a pre-defined checklist. A document "Guide for Evaluation of JRPs and EMRP Researcher Grants," is published with the call documents and sent to the referees. The referees are asked to confirm by e-mail that they are able to agree the both the "Code of Conduct for Referees (and Evaluators)" and the "Declaration of Confidentiality and Any Conflict of Interest" which are annexed to the guide. Actual signature of these two documents by each referee takes place at the Review Conference as a prerequisite for participation.

The Guide includes the marking sheets used for the evaluation, which follow the criteria laid down in the Council text.

For JRPs the criteria are:

- Scientific and/or technical excellence.
- Relevance to the objectives of the EMRP.
- Potential impact through the development, dissemination and use of the project results.
- The quality and efficiency of the implementation and management.

Marking is against each criteria between 0 and 5, a mark of less than 3 against any criteria results in the JRP being considered of insufficient quality to be funded. There are plans to introduce a weighting to each of these criteria in 2011.

The process of evaluation involves the referees receiving the proposals assigned to them several weeks ahead of the Review Conference (although all of the remaining proposals are made available in case a debate is required in the plenary session). The referees are requested to review and make their own preliminary informal marking using the template in the guidance document.

At the Review Conference the referees meet a representative of the proposing consortia (normally the person who will become the JRP-Coordinator if the proposal is successful), enabling referees to clarify their understanding of the proposed project and to test the various claims made prior to marking the JRPs and associated REGs.

Key elements of the Review Conference include:

- Guidance briefings for the referees,
- A poster session for the referees with the proposers,
- Discussion between the referees of their initial thoughts based on their individual remote prior reading and their views following the poster session,
- Development of formal questions by the referees to be put to the proposers,
- A formal question and answer session with the proposers,
- Marking of the projects and associated researcher grants,
- A final plenary session to address any issues arising, and to finalise the Ranked List.

The referees are split into pre-defined groups to allow efficient and effective discussion of the JRPs. Each of the JRPs in the group is marked within the group by consensus, however the bulk of the input into the discussions obviously coming from a minimum of three referees formally assigned to the JRP. Although the discussions amongst the referees involves robust debate they have been able to reach consensus in all cases so far. All of the referees within the group sign the final marking workbooks, and overall this process has worked well, allowing wide and effective debate on the relative merits of the JRPs.

To ensure consistency between the scores from different groups of referees, the training of the EURAMET facilitators concentrates on leading their referees to consensus opinions based on the scoring guidance:

> *0 = Fail: the proposal fails to address the criterion under examination, or cannot be judged due to missing or incomplete information (JRPs only)*

1 = Poor: there are serious inherent weaknesses in relation to the criterion in question, or the criterion is addressed in a cursory and unsatisfactory manner.

2 = Fair: while the proposal broadly addresses the criterion, there are significant weaknesses that would need correcting.

3 = Good: the proposal addresses the criterion well, although certain improvements are possible.

4 = Very Good: the proposal successfully addresses all relevant aspects of the criterion in question. Any shortcomings are minor.

5 = Excellent: the proposal demonstrates excellence in this criterion.

As marks are agreed between the referees, the facilitators keep referring to these definitions. To further promote consistency between the groups the Programme Manager wanders between the groups collecting scores as they developed and listening to the arguments. Where a group appears to be scoring out of line with other groups he will ask questions of the referees against this guidance – prompting them to defend their scores.

The final discussions, where referees from all groups come together to review and approve the single ranked list, demonstrates that scoring is consistent across the groups.

The Review Conference is attended by an independent observer who has access to all documentation and all communications with the referees. He interviews proposers, referees and EURAMET staff and reports to the Commission and EURAMET on the correctness of the process as implemented.

4.4 Stage 3 process (selecting Researcher Grants)

The EMRP Researcher Grant scheme has three fundamental elements:

- Researcher Excellence Grants (REG)
- Researcher Mobility Grants (RMG)
- Early Stage Researcher Mobility Grants (ESRMG)

Researcher Excellence Grants aim at broadening metrological expertise in the programme and are exclusively available to the wider non NMI/DI research community. Researcher Mobility Grants obviously encourage transnational mobility within the programme participants but also provide an opportunity for the European countries not participating in the Article 169 to engage in capacity building of their metrology research capability. The Early Stage Researcher Mobility Grants provide the next generation of metrology researchers from the participating NMIs and DIs with the opportunity to gain transnational experience.

All Researcher Grants are associated with a Joint Research Project and so the call processes are either aligned with a JRP call at Stage 2 above or follow a JRP call once the selected projects are known - Stage 3 REGs and Mobility Grants.

4.4.1 Open Call for ESRMG

This Call opened on 1 April 2010 and will remain open until the end of the programme. A single advert is placed here: http://www.emrponline.eu/adverts/downloads/Advert%20JRPXX-ESRMG01.pdf

This scheme is open to early stage researchers to support them in travelling from one JRP-Partner to another. A salary is not paid, but there are allowances to contribute towards travel, accommodation etc. Importantly, the research to be undertaken must be additional to the JRP tasks.

4.4.2 Call Announcement

The second part of a call is announced in early April following the year in which the JRPs are selected, and closes in early May. Publication is similar to the way that the first part is announced but supplemented by comprehensive advertising for specific Researcher Grant opportunities.

Prior to the Call opening the JRP-Coordinators provide the EMRP-MSU with adverts on a EURAMET template for:

- Stage 2 REGs where the REG-Researcher had not been identified at Stage 2, this research is pre-defined and integral to the related JRP
- Stage 3 REGs where the advert describes some specific additional research (defined by the JRP-Consortium) that compliments the JRP but was not included in the original JRP proposal.
- Open REG adverts where applicants can effectively suggest any research that would add benefit to the JRP (Neither the research, Home Organisation or researcher are defined in the advert)
- RMGs where the advert describes some specific additional research that compliments the JRP
- Open RMGs where the applicant is invited to propose additional research to compliment the JRP

All adverts are placed on http://www.emrponline.eu/adverts.html, and some additional duplicate adverts are also placed on EURAXESS; the European Commission's Researcher Jobs webportal. Individual JRP-Consortia and Home Organisations are encouraged to place adverts on other websites and in literature.

Some JRP-Consortia choose to place a large number of adverts for different specific research needs related to their JRP. Although the total number of advertised researcher months is then in excess of those that could be funded, these JRP-Consortium feel this might encourage competition between the very best researchers. Other JRPs chose to place only a very general advert.

All EMRP Researcher Grant applications have to be made through http://www.emrponline.eu.

4.4.3 EMRP Researcher Grants Evaluation and Selection

The evaluation and selection process is described in Figure 4.

All EMRP Researcher Grants are evaluated according to the criteria set out in the Decision, which are:

- Scientific and/or technical excellence

- Relevance to the objectives of the JRP
- Quality and implementation capacity of the applicant and his/her potential for further progress
- Quality of the proposed activity in scientific training and/or transfer of knowledge

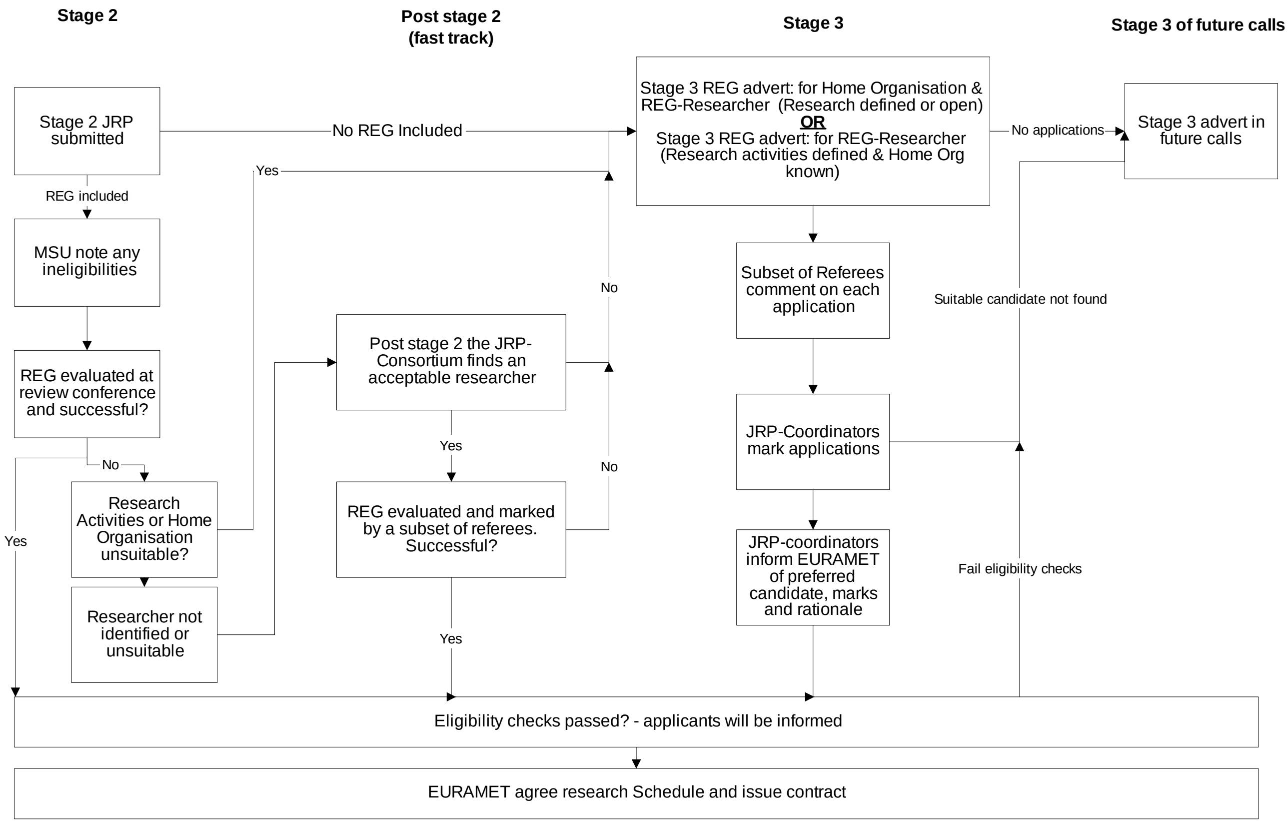


Figure 4: EMRP Researcher Grant Evaluation

The independent referees are involved in evaluating all EMRP Researcher Grants.

- For Stage 2 applications the referees mark the applications and recommend as “fund”, “amend”, or “reapply”. In general this is undertaken at the Review Conference, but for the “post stage 2” re-applications (i.e. where the referees first marked them as “amend”) the marking is done remotely.
- For Stage 3 applications, a subset of the referees make comments on each of the evaluation criteria. The applications and referees comments are then forwarded to the JRP-Coordinators who undertake the marking (against the evaluation criteria), and decide whether any of the applicants are suitable (this can be supported by interviews if they wish). The decision and supporting reasons for their decision are forwarded to EURAMET who then negotiate a contract.

A “REG Research Schedule” is required for each REG (Stage 2 and Stage 3) and also an “RMG Research Schedule” for each of the RMGs. These define the work to be done in a form suitable for a contract document.

4.5 User views and assessment of the call management process

To support this report two surveys were conducted. The first went to the EURAMET members - the EMRP Committee representatives of the 22 EMRP members and the delegates of the 13 non-EMRP members. 23 replies were received from the 35 EURAMET members including 3 that do not participate in the EMRP. In some instances the questionnaires were also answered by the responsible ministries in those countries, but in this report those replies have been joined so that each country only counts once. This questionnaire concentrated on the strategic importance of the programme and answering some of the direct questions asked in the specification for this report.

A second, web-based survey went to 485 people who had interacted with the programme calls in some way. This concentrated on the call processes from submitting a PRT through to contract negotiation. 299 replies were received to the initial questions about the website, but latter questions (e.g. contract negotiation) were only asked of JRP-Coordinators that were successful - 29 replied.

In the following sections responses from EURAMET members are identified by their two letter country code from ISO3166, e.g. **GB -** . Not all responses are reproduced but enough to represent the diversity of views received. Responses from individual participants are not attributed to a person.

First, the EURAMET members were asked:

4.5.1 <u>Are the evaluation and selection procedures efficient and adequate in view of the objectives of the EMRP? What improvements to the process would you like to see in future calls?</u>

The majority of responses were positive about this aspect. Some specific comments were:

CH - In view of the size and scope of the programme, the procedures are adequate. Some of our project proposers had the impression that, so far, the referees were often too academic and did not give enough weight to the potential direct use of project results. The referees coming from academic or fundamental research institutes should be in balance with those coming from the commercial sector.

DE - As part of the iMERA project, the processes have been designed for the EMRP. They have proved to be efficient and appropriate. In future, project proposals could benefit from less details.

EE - The process could benefit from higher transparency.

ES - In general we find the procedures adequate but the elapsed time between two consecutive calls too tight to allow small/medium size NMIs to react with their full capabilities. We propose to increase the number of topics per call and reduce the number of calls, i.e. 1 call every 18 months

FR - ....to have more referees involved in metrology or with a better knowledge in metrology.

IT - The calls for Proposed Research Topics should ask for the identification of well defined open problems requiring ambitious cutting-edge advancements (both theoretical and technological) and where different lines of attack and solutions are possible and worth investigations. The Joint Research Projects should also compete as regards the quality and reliability of the proposed solutions to the same SRT. The participation of a large number of NMIs – say, more than five or six – to the same JRP should be discouraged. The scientific curriculum and publications of the coordinator, work-package leaders, and NMI's key persons should be explicitly accounted for in the JRP evaluation.

PT - From our small experience the access to participate in JRPs is limited for us and the smaller countries. In spite of the actual competition rule be an asset to the program the present situation reveals that only the bigger or more developed countries are defining the JRP themes and JRP participation. As a negative consequence with this program we will increase the differences between European NMIs and difficulties of investment at the national programs.

SE - the procedure for selecting referees in future calls could be a little more 'open' than on previous occasions

TR - No, evaluation and selection procedures need to be improved in order to comply with industrial measurement needs in Europe.

GB - Selection of PRT's would benefit from an overview of where European NMI's are competitive or not with the capability of other regional NMI organisations and how this might impact European Industries ability to compete and innovate.

Applicants were asked:

4.5.2 <u>Do you think that the EMRP website (www.emrponline.eu) contains appropriate information for users to participate in the EMRP calls?</u>

95 % of JRP-Participants responding thought that the EMRP website (www.emrponline.eu) contained appropriate information for users to participate in the EMRP calls. Of the 5 % that did not agree with this the majority suggested that a simplified website with a better structure was needed, but without changing the information contained on the EMRP website.

EURAMET has already started work on improving the structure of the EMRP website and making it more user friendly. Positive feedback has been received on the changes made so far and the process will be continued.

4.5.3 <u>Have you used the EMRP helpline (email or telephone)? - Did you find the advice provided helpful?</u>

Of the 289 respondents, 80 had used the helpline, all found it useful and none offered suggestions for improvement.

4.5.4 <u>Did you find the process of submitting a PRT adequate?- How could the process be improved?</u>

92 % of the JRP-Participants who had submitted a PRT thought that the process of submission was adequate. Of the 8 %, that thought that the process was not adequate, the majority would like

a simplified PRT submission process with reduced administration, whilst others would like to see increased publicity and broader advertisement of the PRT Call.

The EMRP already advertises Stage 1 the call via the EMRP and EURAMET websites, in a minimum of three national newspapers in EMRP participating countries and in a minimum of one international newspaper. The call is also promoted through direct contact with stakeholders and opportunistic presentations at relevant conferences.

Overwhelmingly, the survey showed that JRP-Participants were in favour of the PRT process with only 2 JRP-Participants, less than 1 % of all JRP-Participants who had submitted a PRT, believing that the PRT stage should be discarded and JRP-Proposals freely submitted.

4.5.5 Did you find the website ("EMRP Connections") helpful in finding your Joint Research Project (JRP)-Participants? - How could it be improved?

Of those JRP-Participants who had used EMRP connections, 62 % found the web page helpful in finding their JRP-Partners. Whilst the remaining 38 % did not, approximately a quarter were happy with EMRP connections and would not suggest changing it. A further third believed that JRP-Partners are found through previous collaborations, personal relationships and the Technical Committees rather than via a webpage. The remaining comments centred on increasing the number of participants using EMRP connections as not all 'possible' JRP-Partners sign-up to EMRP connections. The reasons why some 'possible' JRP-Partners do not use EMRP connections was not collected as part of this survey, however as many JRP-Participants believe that JRP-Partners are generally found through previous collaborations and personal relationships, it would seem a logical reason why.

The guidance to all key partners in potential consortia will be strengthened in 2011 to encourage them to register on EMRP Connections before the partnering conferences. This should make the system more useful.

4.5.6 Did you find the process of submitting your JRP proposal adequate? - How could it be improved?

85 % of JRP-Participants found the process of submitting their JRP adequate. Of the 15 % who did not find the process adequate, almost a half believed that the process could be improved by simplifying the JRP-Protocol format but did not specify how. Approximately, a further third stated they would like to see more similarity between the JRP-Protocol and the JRP-Contract format.

EURAMET has already increased the similarity between the JRP-Protocol and the JRP-Contract format over successive calls and it's improvements have helped to reduce duplication of effort for both JRP-Participants and itself. However, some revisions of the JRP-Protocol are necessary to produce an appropriate JRP-Contract. To address this, the EMRP-MSU intends to try and identify the minimum number of necessary revisions to help improve the process further.

4.5.7 Did you find the JRP evaluation process objective and transparent? - How could it be improved?

The survey results on whether the JRP evaluation process was objective and transparent were very interesting as they showed a clear contrast between the response of successful and unsuccessful JRP-Participants. 73 % of successful JRP-Participants believed that the JRP evaluation process was objective and transparent. In contrast only 16 % of unsuccessful JRP-Participants agreed with this.

Comments on why the JRP evaluation process was not objective and transparent could be split into three main categories:

1. a need for more 'expert' referees
2. an increase in the time allowed for discussions at the posters in the review conference
3. increased feedback and visibility of the marking criteria for JRP-Proposals.

Almost half of the comments were for the need for more referees with specific expertise related to the JRP-Proposals; this was suggested by both successful and unsuccessful JRP-Participants.

In accordance with the European Council's decision EURAMET draws all referees from the FP7 expert database. The primary and overriding criteria for the selection of the referees is their scientific and technical competence (and their independence from JRP proposers) and within this the best balance of referee gender, nationality, background etc is sought. The limiting factor on the selection of referees is the number of willing referees in the FP7 expert database. Following the completion of the 2009 call, concerted efforts were made by EURAMET to encourage registration of potential referees on the FP7 expert database. However, these efforts were only partly successful, for two reasons. Firstly there is an apparent reluctance amongst some industry specialists to register on the FP7 database because of issues of confidentiality. Secondly EURAMET encountered a number of malfunctions associated with the database, meaning that some individuals who were known to have registered were not identified through the searches carried out. EURAMET has been working with CORDIS throughout these issues and hopes that the database issues are now resolved.

An increase in the time allowed for discussions at posters in the Review Conference was only suggested by successful JRP-Participants. In contrast 2 unsuccessful JRP-Participants suggested that there was no need for a Review Conference.

Comments for increased feedback and visibility of the marking criteria for JRP-Proposals was only suggested by unsuccessful JRP-Participants. A detailed EURAMET document on the 'Guidance for the Evaluation of JRPs and EMRP Researcher Grants' is published with the call documents for each Call. The document is available on the EMRP website and is also sent to referees. EURAMET is also improving this guidance and supporting an increase in the preparation time for referees.

In preparation for the 2011 call, EURAMET members have been working to identify suitable referees and persuade them to register in the FP7 database. We have also been working with the Commission to ensure that we will be able to use any that do register despite any technical problems with the database.

Timings for the 2011 Review Conference will be adjusted to allow greater time for the referees with the proposers at their posters and to allow greater time for their marking activities. Both these should improve the feedback received either through the formal route or through the discussion at the poster.

4.5.8 Did you find the Researcher Grant application process acceptable? - How could it be improved?

Of the 69 % of JRP-Participants who had made an EMRP Researcher Grant Application, 74 % found the application process acceptable. The remaining 26 % either wanted to simplify the application forms or would like a greater degree of flexibility in candidate eligibility. A common statement was that it was hard to find a suitably well experienced researcher who was also unemployed and therefore, eligible for a Researcher Excellence Grant.

Despite this comment, so far 14 EMRP Researcher Grants have been funded as part of the Call 2009 and 28 as part of Call 2010. This equates to more than one EMRP Researcher Grant per JRP.

In terms of the Researcher Grant application process, EURAMET has recently revised and improved this, including ensuring that a Research Schedule is prepared as part of the application, which should to help make the evaluation process and the contract negotiation progress easier and more streamlined.

When asked “Have REGs enabled the involvement of high quality researchers in your JRP and opened the JRP to the best science?” all those with a REG appointed agreed that it had.

5 Funding

5.1 The EMRP Committee decision

It should be noted that the EMRP Committee is the body within EURAMET charged with the overall responsibility for the EMRP. The EMRP Committee consists of one representative from each of the 22 participating countries, with the Institute for Reference Materials and Measurements (IRMM), an institute of the European Commission's Joint Research Centre, having a standing invite as an observer. Membership of the EMRP is published on the EURAMET website. Voting within the EMRP Committee allows for the significantly varying levels of national commitment to the EMRP, but uses a "square root" system to ensure the decision making process is not dominated by the representatives from the countries with larger national contributions. The EMRP Committee delegates some tasks to a sub-committee, a subset of the full Committee, as it is not practical to carry out some of the tasks in a committee of 22. The full Committee retain overall authority and decision making power.

Immediately following the Review Conference, the full EMRP Committee meets and formally endorses the recommendations of the independent referees with regard to the proposed JRPs and associated Researcher Excellence Grants. The budget for the call and number of SRTs published, is designed so that more projects will be proposed than can be funded (approximately twice) so a funding line has to be drawn in each list.

At this meeting, the Programme Manager presents the Committee with options of what the total and percentage EU contribution to the projects would be (and therefore what national funding would be required) if further projects below the budget line were also funded. Debate in the Committee does not just concentrate on the finances but also considers the detailed referee comments about each project. In 2010 the final decision was to add the two projects in the tan area from the Industry TP and not to add the projects in the Environment TP, thus funding the top 9 projects in Environment and the top 17 in Industry. This was the solution that maximised both the total EU funding to the projects and the percentage EU contribution.

5.2 The Research Council opinion

The EURAMET Research Council meets in December following the Review Conference. Comprehensive information on the process so far is sent to the members ahead of the meeting, including the independent observers report, and a detailed discussion takes place on the day regarding the call and selection process. The Council also provide useful advice to EURAMET regarding the following year's call. At the end of the meeting the Research Council issue a formal opinion to the Commission. Membership of the Research Council is published on the EURAMET website at:

http://www.euramet.org/index.php?id=committeesandbodies

5.3 Contract negotiations

Contract negotiation meetings for the projects selected take place in the first few months of the year. The process starts with face-to-face meetings between project officers from the EMRP-MSU and the individual JRP-Coordinators. The purpose is to convert the JRP-Protocol and the JRP costings as submitted at Stage 2 to form Annex 1 of the contract by

- Addressing the referees' comments
- Ensuring it describes clearly what is to be achieved
- Ensuring it contains enough detail to enable progress to be reported & monitored
- including best practice in the impact and management sections

An important initial task is to remove any overlaps from the projects so that the total budgeted costs of the approved projects could be known and the final EU funding rate for the call set.

The face-to-face meetings take place at the JRP-Coordinator's institute between the JRP-Coordinator and two members of the EMRP-MSU. This approach is chosen as it enables the JRP-Coordinator to be accompanied by a project manager or work package leader. It also provides the opportunity for others within that institute to be briefed and ask questions. Negotiations are concluded by email exchanges over the following weeks.

5.4 User views and assessment of the funding process

EURAMET members were asked:

5.4.1 <u>Is the process of allocating funding to the recipients as you expected from the programme? What improvements to the process would you like to see in future calls?</u>

Almost all replies were favourable - the small number of negative comments were not disagreeing with the funding process described above but rather with the background process run by the proposers during the bidding stage that aims to ensure the bids align with the national commitments:

CH - The process is clear and transparent and should not be changed in future calls.

DE - This process is transparent, efficient and fair.

ES - In our opinion, it would be necessary to have more flexible criteria in the allocation of funds to the DIs. Countries that have their metrological system not centralised have clear disadvantages and see their metrological infrastructures not fully used.

IT - Yes it is. But, funds should be allocated on the basis of the actual project costs, not mainly on the only basis of the labour costs. In addition, minimum/maximum boundaries (also informal) should be weakened. More attention should be paid to small country participation

[This comment on project costs was also included in some of the participant's responses. It comes not from EURAMET rules but by some of the JRP-Coordinators imposing their own domestic rules on the whole consortium. EURAMET guidance will be strengthened to avoid this misunderstanding in future.]

NL - The process employed in the Energy-call, where the budget of the JRP on the waterline was cut significantly by the EMRP-committee, should not be repeated. JRPs should be funded (100 %) or not. Arguments against significant budget cuts in a JRP after the referee conference: the new JRP is not the same as the one ranked by the referees and quality cannot be independently checked, the process of budget-cutting proved to be 'politics driven' solely by coordinator and work package leaders (without real possibilities for other partners to have a voice), the original budget is used in the 'budget-table' even after the budget was cut out by the coordinator which is unfair, etcetera.

SE - Our perception is that the allocation of EMRP funds by nation & by call could be improved in the future:

- The initial allocation per country was made some years ahead of the EMRP based on the national metrology funding at that time. As a result:
    - There were apparently quite different interpretations from country to country about what constituted the national metrology research programme: some countries strictly declared only the true research component of the national budget while other countries seemed to include also other parts of the national metrology programme (such as national standards maintenance funding).
    - The allocations were made at a time before the actual contents and themes of the EMRP were known. The current EMRP themes call on different research competences than could be envisaged when the initial national quotas were set.
    - Some time has passed since setting the national quotas and the national metrology programmes have in several countries evolved and changed direction compared with that current at the time.
    - We have the feeling that when formulating proposals in some JRP cases, a small country has more capability than funding allocation while a larger NMI has more funding allocation than capability. For instance, if a small NMI coordinates one JRP it will limit the possibility to take part in other JRPs not necessarily reflecting the ability to contribute to each JRP.
- The initial allocation of EMRP funds per call over the seven-year programme was also fixed years ahead of the EMRP. As a result:
    - As needs and resources for metrological research evolve and change direction over the years, the initial distribution of EMRP funds per call might become out-of-date, both for each individual participant country as well as for each overall call thematic area.
- To optimise the above-mentioned issues – by country and by call – we would like:
    - to see EURAMET more effectively exploiting the benefits of its implementation of the 'ear-marked' EMRP by being more flexible in allocating funding than would be the case with a 3rd party run programme.
    - This kind of flexibility is particularly valuable for small & medium-sized countries such as Sweden which need to and can prioritise in a way not readily done by larger NMIs who have a more comprehensive coverage.

GB - The UK ministry expected a closer correlation between input and output of funds.

5.4.2 Do you feel the FP7 style of contracting and monitoring projects is appropriate for this Programme?

Simple answers to this question were 75 % Yes, 25 % No, with several abstentions. Whatever the simple answer, the vast majority asked for less bureaucracy in the implementation:

CH - The financial and reporting rules are too complex. The administrative burden for coordinators and participants are too high and are a risk to the acceptance and efficiency of the programme.

DE - The FP7 style is generally working, however, requires a level of administrative effort, which is a risk to the acceptance and the efficiency of the programme. Both documentation of planned resources and of deliverables are too detailed. The FP7 approach limits the flexibility to react to work progress and to scientific developments outside the projects. Although it is possible to modify workpackages and deliverables, the present style creates an atmosphere of a rather mechanical execution of the project along the original plans and reduction of any risk in the financial audits.

EE - too much bureaucracy

FR - the FP7 is too complicated and too administrative. Too much requirements absolutely unnecessary. The lost of time for administrative part (generally details, modification of process during contracts, new rules, etc.) introduce a “general fatigue”, and this introduce a bias for coordinator of JRP or coordinators of WP of JRPs who will spend more time on “administrative part” and less time for the real “research and science”. It will be better to have less “administrative part” and more “scientific audits”.

IT - Yes, it is. In particular it is not safe to change procedures in the middle of the Programme.

SE - This is OK, but EURAMET should not emulate the more bureaucratic aspects of regular FP administration.

GB - There seems to be a large amount of time / effort spent on monitoring projects. It would be useful if this could be reduced by simplification of procedures and reductions in duplicated auditing requirements where adequate arrangements already exist. Could each participating laboratory have a single overarching contract?

These comments are generic to the whole of FP7. EURAMET will watch the framework “simplification” discussions with interest and aim to be on the leading edge of reducing bureaucracy wherever possible.

Because the first A169 projects have only just reached their 6-month reporting stage and no financial reporting has yet been done, participants are not yet seeing the simplification that is already in place in this programme. Specific comments are more likely to be caused by the iMERA-Plus reporting requirements which have been particularly difficult as EURAMET was piloting this initiative.

JRP-Coordinators were asked:

5.4.3 Did you find that the contract negotiations helped to improve your JRP?

66 % of JRP-Coordinators replied positively.

Reasons given for disagreeing with this could be split in to two groups. Just under a third thought that the JRP revisions required during the negotiations process were unnecessary, the remainder believed that during the negotiation process only minor revisions had been suggested by EURAMET and that their JRP-Proposal had not significantly changed. This might suggest that these JRP-Proposals were already well written.

Despite these comments one coordinator stated that they 'appreciated the critical review which was proof that the MSU team went deep into it [their JRP-Proposal]' whilst another described the negotiations as 'helpful'.

5.4.4 Did you find the time to agree your JRP-Contract acceptable?

74 % of the coordinators thought that the time taken to agree their contract was acceptable. Of those that disagreed with this, half stated that the time taken to agree their contract was too long, but did not state why. The remainder commented that the preparation of their contracts had taken much time and effort and had led to a delay in agreeing their contract.

Interestingly, those coordinators who commented that the preparation of their contract had taken much time and effort and delayed the agreement of their contract did believe that the negotiation process had helped to improve their JRP. This suggests that although any revisions of their JRP-Contract, had taken much time and effort they were both necessary and worthwhile.

5.4.5 Has your JRP-Consortium successfully agreed on an Intellectual Property Rights (IPR) arrangement?

Only 37 % of JRP-Participants who responded to the survey stated that their JRP-Consortium had successfully agreed on an Intellectual Property Rights (IPR) arrangement. The remainder were in the early stages of contract negotiation. 83 % of those that had reached agreement had used the standard IP terms in EURAMET's Model JRP-Consortium Agreement. Those JRP-Participants who had, had to make changes had done so to include specific financial clauses or a clause on prior knowledge or for reasons not stated. The split was approximately one third for each of these reasons. Interestingly, not all of these requested changes were accepted by their respective JRP-Consortium.

Less than half (46 %) of the JRP-Participants who responded to the survey believed that their JRP would generate IP. Of these just over 10 % stated they would protect and use this IP via their Consortium Agreement but didn't specify how and just under a third stated they would use a specific IP agreement or patent as appropriate. Surprisingly, over a third of JRP-Participants did not yet know how they would use and protect their IP whilst the remainder were not planning to have any IP protection.

5.4.6 Do the benefits from participating in a JRP outweigh the costs incurred?

The majority of JRP-Participants, 86 %, agreed that the benefits of participating in a JRP outweigh the costs incurred.

Of the 14 % that disagreed, three common comments were stated. Over a third believed that the amount of time spent on JRP coordination, administration and reporting was too high. Approximately a quarter believed that the unfunded cost of producing the JRP-Proposal (bid) was too high. The remaining comments came from JRP-Participants who were from smaller institutes or were unfunded JRP-Partners and therefore, believed that their level of funding was too low.

5.4.7 Did your JRP generate technology that has contributed to other metrology fields (i.e. fields outside of those addressed by your JRP)

This question was only asked of the iMERA Plus JRP-Coordinators as only their projects were close to completion. One-third replied that their project had generated technology that would be used in other metrology fields beyond the main purpose of the JRP.

6 Progress towards enhanced scientific, management and financial integration

The Impact Assessment Report[2] that accompanies the Decision, identifies 10 areas where enhanced scientific, management and financial integration of the European Metrology System is expected as a result of the Programme:

- Co-ordination and integration of NMI and national programmes (cost reduction, reduce fragmentation and duplication, joint strategic direction)
- Addressing Grand Challenges
- New Member State capacity building
- Open access to infrastructures
- Interaction with science community
- Modernisation of the metrology system
- Mobility and human resource development
- Global cooperation and position of Europe in the world
- Support to regulation
- Support to industry and economic growth

The Programme is only just starting, the first projects are submitting their 6 month reports, so many of these desired outcomes are some way in the future – but where the call process contributes to the outcomes then early signs are evident. The following sections record some of these early signs from the Programme Manager's point of view, and the replies to the direct questions from the EURAMET members from their national viewpoint.

6.1 Co-ordination and integration of NMI and national programmes

The greatest integration of the national metrology programmes comes through the construction of the Selected Research Topics (SRT) and the proposals in response to those. The programme is in its early days and still building, but over the life of the programme nearly half the total metrology research in the EMRP member organisations will be funded through the Programme. This provides a great focus for the scientists working in the National Metrology Institutes, as to see their work funded they need to engage in collaboration across Europe.

The process starts long before a call is announced. Each Technical Committee (TC) in EURAMET meets at least annually to discuss plans for future EMRP calls. Contact Persons from each member will discuss their future plans, stakeholder needs that they have identified in their countries, and outline work they would like to do to address those needs. Where a consensus emerges in a TC that a need is significant enough to be best addressed collaboratively then interested parties will refine the idea and submit a Potential Research Topic (PRT) when the call is announced. Where the need is best addressed nationally then it will be left for individual national responses.

[2] COM(2008) 814 final

When the PRTs are formed into SRTs by the EMRP Committee then a higher level of integration occurs. The EMRP Committee members bring their knowledge of national capabilities and national priorities, they think at a strategic level above the individual technical areas and prioritise topics where the stakeholder need is clearly demonstrated and the benefits to be gained from the involvement of the metrology community are greatest. They will construct SRTs designed to bring about change in the community, requiring different technical areas to cooperate to achieve an objective where this would not happen naturally due to organisational boundaries, or requiring the active engagement of industry, regulators or standards bodies throughout a project where the technical community would prefer merely to present the final results.

In setting the indicative budgets by TP, the EMRP Committee take a joint strategic view on priorities for metrology research across Europe. In 2010, following the decision on the SRTs, the Committee took the view that a greater need had been identified in the Industry TP than in the Environment TP and moved 3 M€ from Environment to Industry. In 2011 a similar decision was made to move 2.5 M€ from SI to Health. These decisions are not about individual projects but strategic direction and feed through to national programmes and resource allocations within the NMIs.

Above the EMRP Committee the national programme owners have aided integration by relinquishing control over a large proportion of their national programmes. As proposals are developed in response to the SRTs they can control that bid process, they can choose how to spread their resources across the proposals being prepared. In theory they could withdraw from a bid at the end of that process, although that is unlikely as it would cause some damage to the relationship with their partners and could affect other proposals. But, once the bid is submitted they relinquish control, the result is in the hands of the independent referees. Only half the proposals will be funded, the competition between the SRTs being based on scientific excellence, relevance, potential impact, and quality. This can result in national priorities being frustrated if they have failed to convince the referees that their proposals are the best. This was certainly the case in the 2010 Environment TP where the UK was quite shocked to see several of its flagship projects lost.

The size of the funded JRPs (typically 3 M€) reduces fragmentation and duplication. Critical mass is brought to bear on clear objectives, with agreed project plans and enhanced stakeholder engagement. What could have been 20 independent research teams tinkering around a common area becomes a focused activity driven by the stakeholders. As an example consider the 19 commercial organisations that are members of the advisory group[3] for ENG03 LNG.

A joint strategic direction between the EMRP members is developed around the programme themes. The existence of the programme outline[4] and the process for developing the scope for the calls are the embodiment of that joint strategy. As the programme develops this may widen to cover other areas, the wider responsibilities of EURAMET may bring a closer integration between the members, but at present there are very significant differences between the members in their size, responsibilities and organisational structure which limit where they prefer to cooperate and where they choose to compete with each other.

The EURAMET members were asked:

[3] http://www.lngmetrology.info/advisory_group
[4] http://www.euramet.org/index.php?id=documents0

6.1.1 <u>In your view, what progress has been achieved towards coordination and integration of the national metrology research programmes by the EMRP? What further steps to enhance this could be taken?</u>

CH - Today, a substantial part of the R&D in metrology in Europe is carried in the framework of the EMRP. The coordination of the work is mainly taking place at the project level. The coordination and integration at the level of the national programmes is still rather indirect. In addition, due to the significant difference between the members (e.g. size and organisational structure), there is a risk that the needs of smaller countries are not properly addressed. Further steps towards better integration could be:

- Coordinated planning and sharing of special research facilities to avoid unnecessary double investments
- Creation of European centres of competence in metrology research: bundling of decentralised competence in a network of researchers and institutions working on a thematic focus.

DE - iMERA-plus and EMRP have already created a step change in the way the NMIs and DI work together, attract non-NMI/DI partners and represent themselves jointly to the outside world. On the international scale EURAMET has gained a lot of reputation and recognition. The national research programmes have been integrated and coordinated to a large extent. As an estimation, at least 50 % of the national metrology research all over Europe is affected by this integration through the EMRP.

The coordination has led a concentration of research to prioritised fields especially in medium-sized countries, however not to a reduction of duplication in all cases. Such a further concentration will require the additional consideration of services and other metrological activities beyond research. EURAMET has taken first steps in this direction and provides best opportunities to continue this effort.

ES - Little impact due to the large distribution of compromises and our reduced participation. For enhancing we would like to open the participation to other R&D national institutions that usually participate in our national research programme.

FI - EMRP has already improved coordination and integration: Actors within national programmes need to search the best ideas and work together in order to be competitive in the proposal selection. Collaboration between national metrology research programmes has genuinely improved.

FR - to have JRP-Coordinators who are real coordinators on a subject and not behave as “directors of projects” without discussions within a group on the scientific goal to achieve. More clear instructions should be given to JRP coordinators in the sense that a JRP is a “research project” with an objective and if some results of a workpackage can modify a part of the content this is normal in research, even it not fit exactly to one of the first objective.

IT - Since the NMIs’ participation to the EMRP does not emerge from nothing and it impacts of the development of the NMI’s own research capabilities, the cooperation/integration could be enhanced by panels of experts drawn from both the EMRP and external scientific communities which review the individual NMIs’ programs with the aim of identifying how to improve them and their coordination/integration, how to tension priorities in funding, if continuing to run an activity.

LT - The objective of EMRP is the coordination and integration of National Programmes. It is important to include small countries to this process, which could have or where are already exist rather strong groups of researches.

NL - In the preparation of PRT's lively discussions occur in the metrology world, leading to prioritisation of subjects with pan-European impact and need. In the later SRT/JRP-process we feel that usually the really strong NMIs in a particular field are 'survivors' in the JRP, after often strong debate amongst NMIs. We feel the referee-process (independent of NMIs) is extremely useful in selecting the topics with highest social/economical relevance (while NMIs are not always capable of judging this). National program owners, although they can participate and influence the preparatory stages, are not the final decision makers and thus European integration/coordination is progressed although in practice national bodies still have to get used to this.

At NMIs like ours, a rejection of a JRP sometimes leads to the decision to not take on the subject anymore (on a national scale). In the preparatory stage for a JRP, if we are not successful in acquiring a good and significant participation/role in certain JRPs, a consequence might be to reduce our ambitions in that particular subject altogether (also on a national scale) if our conclusion is that other NMIs will be better/faster at it, helped by to 'EMRP-acceleration'.

SE - We are pleased (as is the Commission) in the degree of integration already achieved by EURAMET in the EMRP, which appears to be one of the most integrated programmes of the whole ERA in any subject field. The nominal 25 % degree of EMRP integration compares favourably with the 5 % integration level of for instance academic research programmes. An important further step for the future is to recognise that it is a slow and in part challenging process to evolve from purely national thinking to including a truly 'European' aspect in each national programme. Instruments such as Art185 are quite different from regular FP research programmes (ear-marking, different co-funding rates, different success rates etc) which need to be appreciated by decision-makers. Raising awareness of EURAMET's success amongst our members is an important step, as is making members feel that they are engaged in formulation future strategy. There is also growing appreciation of the equally important contributions from researchers from both 'large' and 'small' NMIs alike. Statements such as "small NMIs cannot coordinate" are heard less and less.

SI - The progress has been achieved in knowing each other better and finding what are the capabilities of others and there seems to be no further progress in terms of integration. I have a feeling that we need to overcome this level. Perhaps exchange of scientific personnel, say 2 weeks for two scientists (regular, not REG or RMG!) to work in other labs per year, would initiate this process. This should be a request contained in the project protocol.

TR - Outputs of the JRPs under EMRP are quite impressive. Several scientific projects would have not been developed without EMRP funds. EMRP stimulated better cooperation between research organisations even from the outside of the National Metrology System. Better mechanism for knowledge transfer and dissemination of accumulated knowledge has to be established.

GB - There has been some success in achieving coordination of national programmes through the EMRP. For example, in the 2010 Industry call, the JRP "High temperature metrology for industrial applications" has led to strong coordination within a small tightly knit network of NMIs who will focus on the topic on an EU-wide front, but also satisfying national objectives. This has only been possible through sharing and coordinating NMI national research programmes and the partnership that has evolved is committed to working together on future calls.

As an indirect result of the programme the UK has brought representatives from other European or international bodies into the process for determining its national programme. Encouraging this in other countries would further enhance co-ordination

6.1.2 Does the "real common pot" for researcher grants operate effectively? Would it work for other parts of the Programme?

Only 3 respondents gave an unambiguous "Yes" to the first part of this question. No one replied positively to the second part. Most replies were abstentions, waiting for greater evidence of the grants working in practice. Considering only 9 JRPs are contracted at present and only 8 REGs employed, this is perhaps not surprising.

CH - The real common pot model works well for researcher grants and the management of the programme. It would not be adequate for the research activities carried out by NMIs and DIs. These activities heavily rely on existing metrological infrastructure and the researchers on permanent contracts already active in the participating institutes. The contracts of permanent staff cannot depend on external project decision.

DE - The grant system is appropriate only in some cases. Some sort of potential home organisation such as Fraunhofer-institutes has principle administrative problems to host grant recipients, they in fact neither apply for Marie-Curie grants. Very experienced researchers usually occupy permanent positions, but unfortunately are not eligible for grants. Thus a very important target group of excellent researcher, like professors at universities wishing to spend part of their time for contributions in JRPs, can not be (co-)funded.

EE - No, it does not. I think that one of the reasons is in lack of personnel at NMIs and DIs. I do not believe that "real common pot" would work for other parts of the Programme either.

ES - The idea of the common pot for grants is good for integration despite, at the moment; the success of the calls for REGs and RMGs is questionable. This tool is not enough attractive for enterprises or institutions other than NMIs or DIs. The procedure is too elaborated and time consuming.

FI - Grants for experts with permanent position in an organisation are not possible. This is a shortcoming.

SE - It seems to work for the researcher grants. We are not however keen to extend the "real common pot" to other parts.

GB - It is difficult to introduce the "real common pot" to the main parts of the programme because much of the national funding is tied to ensuring the viability of National Metrology Institutes. If there was a significant increase in the real common pot facilities the capabilities at these institutes would be threatened.

6.1.3 How strong is the leverage effect from the community contribution on your participation in the programme?

To understand this leverage effect the EURAMET members were asked to respond with numerical answers to three scenarios:

1. How they would change their National Commitment with hindsight, assuming the EU Contribution rate remained at 50 %
2. What that National Commitment would be if the EU Contribution rate had been 33 % as in iMERA-Plus.
3. What that National Commitment would be if the EU Contribution rate had been 20 % as in another A169.

Replies were received from 20 members representing 397 M€ of the 400 M€ programme size:

1. Under scenario 1 none would reduce their commitment, 9 from the 20 **[CZ, DK, EE, FR, NO, SI, SE, TR, PL]** would increase it by 25 % or more. The programme size would have increased from 397 M€ to 424 M€.
2. Under scenario 2 many would reduce their commitment. The programme size would have decreased from 397 M€ to 147 M€.
3. Under scenario 3 many would consider not participating. The programme size would have decreased from 397 M€ to 30 M€.

These results may be surprising, but many members have very simple methods of allocating national funding and very basic systems for managing that work in their own laboratories. They see the overhead of the EMRP call process and reporting process as a significant barrier which must be overcome before the benefits of closer integration can be realised. This Swiss comment speaks for most:

CH - The costs for the preparation (phase 1 and phase 2) and the management of the projects are substantial. For this reason the participation becomes much less attractive if the EU funding rate decreases. At 33 % the commitment would be around 50 % of the actual value.

6.1.4 <u>Through the coordination & integration of the national metrology research programmes, the EMRP is designed to reduce overlaps and duplication across Europe and thereby release additional resources for other activities in the National Budgets. Please estimate the percentage of your national budget released in this way</u>

Respondents found it difficult to estimate this at this early stage of the programme. Some estimates were:

CH - Currently, following iMERA-Plus and the 2009 & 2010 calls - 10 % of the R&D budget. When all the planned calls are complete - 25 % of the R&D budget.

DE - None, since mostly urgently needed extra work has been addressed.

NL - This may not be the best way to quantify this. As mentioned under 6.1.1, the consequence of EMRP-participation is highest for the future developments and subjects. In other words, more focus (=budget) will be allocated to ‘successful’ subjects (JRPs) and less to the other metrology subjects, giving a boost to a focusing of metrology activities, part of which would have been done without EMRP as well (but much slower and with less impact). It is difficult to consider this as ‘releasing national budget’.

SI - Around 10 % of National metrology resources have been released and are estimated to stay that way till the all calls are complete.

UK - In a time of pressure on national budgets the EMRP programme has allowed the UK NMI's to develop the capability required by UK industry quicker and more efficiently by cross Europe coordination and integration.

6.2 Addressing Grand Challenges

The programme has been structured around Grand Challenges, so the intention to address this is clear to see. All the projects so far selected in the Environment TP and the Energy TP have this key driver but work on Smart Grids (ENG04), HVDC (ENG07), Remote measurement of climate parameters (ENV04), and the Water Framework Directive (ENV08) may be those where it is easiest to demonstrate this to the non specialist.

6.2.1 <u>What benefits do you see at your national level, from the Programme and calls being structured around "Grand Challenges"? What alternative structure could have brought greater benefits?</u>

CH - The concept of the "Grand challenges" allows addressing specific stakeholder needs across the boundaries given by the traditional technical fields. At the national level, the concept helped to establish stakeholder connections (e.g. in the energy sector) which did not exist before. Besides the "grand challenges", the programme should include an element which allows to address the specific needs of industry (single discipline or multidisciplinary).

DE - The "Grand Challenge" approach significantly impacted the way PTB and partly the DIs in Germany work. PTB is convinced that this approach leads to a more efficient research strategy, and better visibility and impact of the results. Furthermore, this approach leads to fruitful, more interdisciplinary approaches. PTB wishes to continue the "Grand Challenge" approach. The approach facilitates to explain the need and impact of metrological research to politics and public, and thus dissemination and visibility.

DK - The call themes are closely related to national research themes as well, and thus provides a vehicle for closer integration of metrology and other research areas.

FR - a great benefit mainly to explain what metrology is for. We organised our national mid-term programme in the same way.

IT - "Grand Challenges" have given a strong pulse in the correspondent areas. Significant alternative structures are not easily imagined. However a higher level of separation among energy, health and environment is desirable. Moreover the programme should be periodically updated to account for the experience gained.

PL - Although we have not seen the benefits of the Programme yet, it seems that its structure is well designed, because a single "Grand Challenge" covers many different research fields simultaneously, so that researchers of various specialties can address the "challenge" together. If it were structured along the lines of certain types of measurements, each call would have addressed much narrower group of researchers.

SE - This gives a 'political correctness' which is of benefit when motivating our national metrology for programme owners and other stakeholder groups. It is obviously in line with our own ambitions to meet the Grand Challenges. For future programmes, it is important to emphasise more the complete 'innovation chain', i.e. more basic science and more product-relevance without sacrificing our Metrology mission.

6.3 New Member State capacity building

The elements of the Programme designed to assist new Member States building capacity in metrology have not begun to take effect yet. The mobility grants are the key mechanism and they require JRPs to be at least selected, they may actually not attract sufficient attention until the JRPs are working and publicising results. No applications for RMGs in 2010 came from non-EMRP members.

We still receive indications from EURAMET members outside the EMRP that they aspire to join - the conditions for Greece to join have been agreed and we only await their final confirmation, Cyprus was the last member to announce that it would join when it had further developed its national programme.

6.3.1 Does the programme contribute sufficiently to the development of metrology research capabilities in non-participating states and can it integrate them?

CH - The grants available as part of the programme and the dissemination activities carried out within the individual projects are powerful tools to integrate the non-participating countries. It seems, that non-participating countries have not taken full profit of the possibilities so far. EURAMET should take a more active role (through its technical committees and focus groups) to promote the existing tools.

CY - Despite the fact that Cyprus did not show interest in participating in any RMG, we believe that these Grants contribute to the development of metrology research capabilities for those countries that take advantage of them.

DE - The mechanism of mobility grants for capacity building in non-participating states has so far not been used widely. However, these states benefit from the deeper integration of the NMIs/DIs in EURAMET in an indirect way. They are better represented on European and international level and they receive more support from EURAMET such as through the "Focus group development".

ES - No, the structure of the programme does not give enough room for non-participating countries. RMGs could be a way to integrate them but due to the present economic situation and the problems of all NMIs to maintain their permanent staff, it is going to be very difficult to have success.

LT - The EMRP doesn't contribute sufficiently the development of metrology research capabilities in non-participating states, because countries with the lower economic potential can't provide co-financing, so they can't participate in the Programme.

RS - Our view is that some conditions of participation should be more clarified, on example, by organising some workshops or debates for smaller NMI which is not the EMRP member.

SE - We feel it important that any country which needs to develop its national metrology can turn to EURAMET for assistance, if required.

GB - A good example of success in this area is the iMERA+ Power & Energy project. This has re-invigorated the Power & Energy community from a state of little cooperation before the project, to a lively and integrated community which now has a EURAMET sub-committee which includes several non-participating nations. Results and experiences are being readily shared by all participants and non-participating states may then choose to develop niche capabilities in specialist areas as opposed to replicating existing capability.

6.4 Open access to infrastructures

The infrastructures of key interest to the current projects are those provided by commercial stakeholders to allow the outputs of projects to be tested (e.g. in ENG03 LNG and ENG04 Smartgrids). This access would not be obtained without the support of the programme.

However, in terms of the impact assessment, the authors probably expected this heading to be about the NMIs providing access to their infrastructure to a wider community. The projects will promote this, as they become more mature, through the REGs. REGs in the early stages of projects typically bring expertise into the project from academia, later in the projects, new REGs will take the results out to the stakeholders and at this point access will be provided to the facilities developed by those projects.

Of course, the existing metrology research infrastructures are open to all EURAMET members and jointly used in the EMRP projects - but that was one of the founding principles of Euromet and has been the case since the 1980's.

6.4.1 Is the programme sufficiently accessible to research actors other than NMIs and DIs? If not, in what way would you like to open the Programme?

CH - The access of non-NMI research actors is quite limited. The programme owners of the participating countries should have the possibility to invite non-NMI/DI research institutes to participate in JRPs if deemed necessary.

DE - It is appropriate that the programme focuses on NMIs and DIs, in view of their concentrated metrology research capabilities. The NMIs and DIs always have been cooperating with other research institutions, universities, or industrial research labs. The grant system is limited in attracting and funding their participation. Most EURAMET members are interested in opening the funded project participations to this type of partners in future. In parallel, however, the strategy finding and the major part of the programme execution must stay with the NMIs and DIs in view of their capabilities and responsibilities to provide metrology infrastructure and services.

The German ministry replied - Resources for metrology are bound to dedicated institutes in Germany, mainly PTB. Thus, it is appropriate that EMRP focuses on NMIs and DI's. The Programme could be opened to other research institutes, prerequisite is an adequate regulation for the national commitment.

DK - Probably not. The lack of available cofounding limits the possibility for other parties to join research projects (e.g. universities).

ES - No. Only if the programme is open to all research actors in metrology the overlaps will be avoided. This will mean an increase of the national contributions of each country and therefore an increase in the contribution of the commission. In this scenario NMIs would take a very important role coordinating the participation of the research actors within their countries supporting them and assuring their commitments.

FI - More flexible grant scheme to allow permanent staff in outside organisations to participate.

FR - yes, and grants is a nice way to open to some "external" organisations other than NMIs and DIs. we should take care to not open to organisation without sustainable activities in metrology, otherwise, it is only R&D, and the goal is totally different.

IT - Metrology needs merging and competition into a wider R&D framework. Therefore, the barriers to entry should be weakened. For instance, provided NMI coordination and the participation of two additional NMIs, the participation of funded non-NMI partners (from industry, research institutions, and academia) should be allowed.

NL - Yes. I see no immediate reason to open up the programme

PL - The EMRP is not sufficiently accessible to institutions which do not have the status of an NMI or a DI. The same concerns accessibility of the programme to individual researchers. We would gladly see more flexibility about that; relaxing the rules on participation would be welcome.

RS - As Serbia has some scientific metrology capacities located in scientific institutes which are not yet DI, but DMDM has MoU or Contract of Cooperation with them and it would be very precious for us to have possibility to include them in such programmes. Everything is clear with mobility grants but if we have some possibility to realise project, or part of the project in their premises, we are not aware how it is possible. We would like, on example, to see clearly such manners. Collaboration on some project with some other NMI/NMIs or include us in early stage of determination of subject proposals.

SI - I believe it is. The REG and RMG scheme works well and integrates the interested researchers in such an extent that positions even remain free. If the programme would be further open for institutions, the program may quickly diverge to a parallel FP7 initiative and specific metrology content (and European integration) would be lost.

TR - The programme is not sufficiently accessible to research actors other than NMIs and DIs. It should allow the transfer EU funds to other institutes. Participation in the programme as an unfunded partner is not attractive. The program should be attractive (not necessary at the financial basis) for the bodies to help developing national standards and national metrology.

GB - The work on the Power and Energy JRP has underpinned power quality compliance testing and electricity revenue metering nationally and across the EU. Several site measurements on behalf of electricity transmission and distribution operators have been made and future collaboration is envisaged to support Smart Grid initiatives in various countries. This would have been much more difficult to achieve, were it not for EMRP, and certainly would not have been achieved in a co-coordinated manner.

A future programme could be opened by allowing other research organisations to apply for EMRP funds, provided that the overall programme was larger and that they had their own matching funding.

Recommendation - That EURAMET members and their funding ministries explore mechanisms that would allow any future programmes to be more accessible to research actors other than NMIs and DIs.

6.4.2 <u>Are the eligibility criteria for participating in the programme adequate to ensure nondiscriminatory access? If not, what are the "barriers to entry"?</u>

The Programme Manager gave guidance that while the question above [6.4.1] was about the ability of organisations to participate in the Programme, this question referred to the ability of individuals to participate e.g. discrimination on the grounds of age or gender. No respondent identified such issues.

GB - We see no difference between EMRP opportunities for long term secondment with practices already established within NPL. Such barriers that exist are dependent on the circumstances of the individual.

6.5 Interaction with science community

Enhanced interaction with the wider science community occurs primarily through collecting needs at the PRT stage and engagement in the projects through REGs and stakeholder advisory groups. Of course, the metrology community is an integral part of the science community and has always engaged in publication and conferences as part of that community.

In 2010, 18 % of the PRTs evaluated at Stage 1 came directly from the wider science community. There will have been co-authors from this community on many more.

From the nine projects contracted so far, there are 10 unfunded partners who are not NMIs or DIs, and 8 Home Organisations, so there are an average of 2 RTD performers per project that are not an NMI or DI.

6.5.1 <u>What is the contribution of the EMRP to the European Research Area? How has interaction of the national metrology infrastructures with the wider science community been enhanced by the Programme?</u>

CH - The EMRP helped to intensify the interaction with the wider science community. As an example, a link between METAS and the National Research Programme in the field of energy was established as a consequence of the energy call in 2009.

DE - In Germany, the metrology community is already strongly linked with the wider science community. It is important, that the relevant partners are well linked, not their sheer number. In addition to a better interaction between the NMI and the DIs, the EMRP has helped to link better on European scale. This is best demonstrated by the various coauthors of PRTs and the partners of the JRP consortia.

EE - The contribution of the EMRP to the European Research Area is in tighter communication with the universities and research organisations

IT - The EMRP contribution to the European research Area has been strong mainly in the fundamental metrology. However the interaction of the national metrology infrastructures with the wider science community been weekly enhanced. Interaction between metrological laboratories and academia has been only started in the most advanced areas, but not fully developed.

NL - Yes, there has been quite some extra interaction with the 'wider science community' and also with the wider business community. The significant attention which is put on stakeholder support has lead to many more contacts and discussions with universities and industry, to find out about their needs, their current requirements, the state-of-the-art in technology and eventually, participation as funded (REG) and non-funded partners. Various examples can be given, e.g. LNG, Smart Grids, and many more.

SE - The process of formulating EMRP proposals with other stakeholders and researcher groups has increased awareness of national metrology, even in cases where JRPs don't include stakeholders.

GB - Through the EMRP project, Metrology for Energy Harvesting, NPL has been able to contribute important metrological capability to an FP7 consortium developing novel nanostructured thermoelectric materials for coolers and energy sources. The consortium includes leading European research institutions e.g. KTH Sweden, Fraunhofer IPM and major European companies e.g. Electrolux and VW Group.

6.6 Modernisation of the metrology system

The authors of the Impact Assessment expected "modernisation" to involve a greater investment in public metrology research to cover the increasing number of research needs, while still servicing existing "traditional" demands. They also expected metrology to become more organised around themes rather than technologies.

The programme is certainly bringing a new stream of investment to the metrology community based around themes and the increasing number of research needs rather than technologies. In some countries the national funding is coming under great pressure in the current economic climate and some new thinking may be required to service the "traditional" demands.

The basic structure of metrology will always be around basic measurement technologies - but in the same way that many universities have an outward facing "Centre for X" that merely pulls relevant expertise from the traditional departments to address a current issue, then the metrology community are likely to develop a similar matrix approach. Examples can already be seen at PTB and NPL.

6.6.1 <u>In what way has the EMRP contributed to the "modernisation" of your national metrology system?</u>

AT - enables to work with other institutes on projects which could not be done by BEV alone.

CH - The EMRP helps to improve the strategic planning, the quality of the national R&D programme and the cross disciplinary thinking.

DE - The way the EMRP addresses grand challenges and stakeholder needs, and the European dimension of the projects have greatly impacted the way the partners work. With the help of the EMRP the DIs are much better integrated in the metrology system. EURAMET will discuss how in a possible successor programme the market-takeup side of the innovation chain can be better addressed and how excellent new partners can be found and co-funded.

DK - In a small country with many DI's, the EMRP has facilitated a new level of cooperation and collaboration.

EE - New services in chemistry area and thermography have been developed. International co-operation will be enhanced.

ES - We don't believe that the EMRP has contributed to the modernisation of our national metrology system. What has made is to drive us to a strong commitment with the R&D in metrology.

FR - new way of presentation of projects, to pay more attention on the objective and impact of projects developed. To try to be more opened to new and "transverse" fields like energy, health at national level, to improve the communication on the research developed to a more "general public", including Government, and to continue to improve communication with universities and industries on societal and industrial grand challenges.

HU - The metrology system in Hungary is well designed, we do not think that any modernisation is required at the near future.

IT - EMRP has contributed to modernisation of the national metrology system giving strong impulses in the new areas where the metrological activity was rather poor.

NL - Especially the extra focus leads to higher impact projects. Moreover, the structuring around grand challenges has required strategic focus as well. Project management and proposal submission has also been professionalised.

TR - Significant mobility internally at the NMI could be observed. EMRP has a high contribution in motivation of our staff in common multinational project, and experience in a management of EU funded projects gained. Certainly cooperation with leading NMIs and DIs was enhanced. In addition, gap between our country and EU was minimised. It is very difficult to estimate the real impact at the current stage. More time is required for the evaluation.

GB - The EMRP has raised the general level of metrology infrastructure in the less developed nations. For the leading European NMI's including the UK the programme needs to have the explicit objective of making the European metrology infrastructure internationally competitive and introduce methods of measuring this.

6.7 Mobility and human resource development

The Researcher Grant schemes are the key instrument of the Programme for this area.

The REGs are just starting. While there is enthusiasm for them in the projects, the management effort of arranging and contracting them is out of proportion to the rest of the programme. Perhaps this will improve as we develop a community that has experience of them. It is too early to look for evidence of what they have done for the community rather than the individual projects.

5 RMGs have been agreed for the Energy call (see Table 5) and applications for RMGs associated with the 2011 call are currently being evaluated. 1 application for an Early Stage Researcher Mobility Grant has been received. The opportunities presented by the mobility aspects of the programme require much more promotion by EURAMET members to their staff.

6.7.1 How has your national programme benefited from the mobility and human resource development aspects of the EMRP?

AT - exchange of staff

DE - Germany's national programme has not very much benefited from the mobility aspects, which is appropriate, because Germany is not the focus of these measures.

FI - National programme has benefited a lot. MIKES researchers have visited PTB, NPL and CEM (several visits for a period of several months). Researchers from PTB, LNE and (soon) from UME have done parts of the projects here in Finland.

TR - We have not benefited from the mobility and human resources grants yet. Scientific project such as Watt balance and Boltzmann Constant project should be financed by scientific budget not by metrology budget.

6.8 Global cooperation and position of Europe in the world

The rest of the world views the EMRP with a mix of admiration and envy. There is no mechanism by which the other regions could adopt such a programme. Australia has expressed interest in formal cooperation and the BIPM would like to take part but do not want to compromise their international status.

The ability of Europe to agree issues within its region and then go to the international fora with a large block vote, has long been a strength of the European Standards Organisations and EURAMET. The Programme will strengthen that position in specific fields as the projects get underway. Perhaps the first evidence will be found in ENG04 Smartgrids.

6.8.1 How has the programme enhanced cooperation between your National Metrology System and the world beyond Europe?

CH - Through the EMRP Europe strengthens its position in world metrology. Non-European actors become interested to participate as non-funded partners in EMRP projects. Through this channel, the cooperation between our metrology system and the world beyond Europe is enforced.

DE - Metrology institutions worldwide are very interested in the development of the EMRP. PTB has received a number of questions and requests about participation of institutions outside Europe. Indeed, several institutions outside Europe already have managed to participate as unfunded partners.

SE - The EMRP projects we're active in (including HVDC which we coordinate) have attracted global interest. More should be done to include global engagement in the future.

GB - The Nimtech JRP (funded by the iMERA+ call, and therefore coming to a conclusion) the work has extended beyond EMRP, since members are often part of ISO and this has enabled some of the work to get recognised globally, particularly in North America

The results of the iMERA+ Power and Energy project have been discussed in detail with senior colleagues from beyond the EU; specifically US and Australia. The project outcomes have also been extensively aired at major international metrology conferences such as the Conference on Precision Electromagnetic Measurements.

6.9 Support to regulation

Support to regulation was a key driver in the 2010 Environment call. Particular examples are ENV08 on the Water Framework Directive, ENV09 on radioactive waste management and ENV01 on ambient air quality.

6.9.1 <u>How has the programme supported better regulation in your country?</u>

CH - The programme has so far helped to establish the basis and the metrological infrastructure needed to set up and to enforce the regulation, e.g. in the following fields:

- Consumer protection, smart metering
- Exhaust emission for motor vehicles

DE - The direct impact on regulation is not easy to specify. TPs with focus on regulatory issues like TP environment have just started. In general, impact on regulation and standardisation is in many cases considered as a process flanking the JRPs or starting after JRP project end. The responsibilities of the NMIs and DIs in regulation and standardisation guarantee the long term impact of the programme.

SE - It is too early to say, but we see potential in linking EMRP to standardisation, conformity assessment and regulation, in line with EURAMET's MoU with CEN/CENELEC etc. Examples include Smart Grids and nanometrology.

GB - The Nimtech project has supported the need for FreeForm standards in UK, resulting in the proposed development of a UK standard with the support of BSI. Whilst this may have been achieved in a longer timescale by the national programme, collaborative work with other NMIs has provided clarity of EU activity and supported the need for UK action.

Calibration methods for power quality compliance testing and electricity revenue metering have been developed to underpin the EU EMC directive. Further, new techniques developed with the support of EMRP places the NMIs in a position to support, from the start, emerging international standards for renewable and distributed energy generation; the European Supergrid.

6.10 Support to industry and economic growth

Support to industry and economic growth was a key driver in the 2010 call for Industry. Rather than list the objectives of individual projects, it may better evidence to list the 44 commercial concerns that we expect to contract either as unfunded partners or Home Organisations in 2011. These are shown in Table 12.

Agilent	Insplorion AB
Agilent Germany R&D & Marketing	ION-TOF Technologies GmbH
Agilent Technologies Österreich GmbH	JCMwave GMbH
Austrian Institute of Technology GmbH	Johnson Matthey Plc.
Bruker Nano GmbH	Kipp&Zonen B.V.
Cinquepascal S.r.l.	Kratos Analytical Ltd.
CMS Ing. Dr. Schreder GmbH	Lazzero Tecnologie S.r.l.
Componentes Híbridos y Láseres de Fibra Óptica S.L.	Meggitt Sensing System
CSM Instruments	Nanocomp Oy Ltd
Danfoss A/S	TNO
Deutsches Zentrum f. Luft- und Raumfahrt e.V.	NGF EUROPE Limited
Endress & Hauser Wetzer GmbH + Co. KG	NMDG NV
ENVINET a.s.	Omicron NanoTechnology GmbH
esz AG	PANalytical B.V.
GDF SUEZ	Scienion AG
Helmholtz-Zentrum Berlin für Materialien und Energie GmbH	SolarPrint Limited
Hitachi Europe Ltd	SPECS Surface Nano Analysis GmbH
IBS Precision Engineering bv	tascon GmbH
ID Quantique SA	Thermo Fisher Scientific Inc.
Inficon GmbH	TOTAL SA
INFICON Limited	VACOM - Vakuum Komponenten und Messtechnik GmbH
Innopsys	XPRESS Precision Engineering B.V.

Table 12: Commercial concerns likely to be contracted as unfunded partners or Home Organisations in 2011 following the 2010 call

6.10.1 <u>How has the programme supported industry and economic growth in your country? What further steps to enhance this could be taken?</u>

DE - Impact on industrial growth usually takes longer than the typical project duration of three years. There are examples of market take up of results of JRPs (e.g. Josephson voltage standards and coordinate measurement of large objects), but the majority of this kind of impact will take longer. The responsibilities of the NMIs and DIs for support of industry guarantee the long term impact of the programme.

FI - PRTs submitted by non-NMI/DI organisations should receive more careful consideration.

SI - There was quite some interest from industry in Slovenia for selected EMRP research projects. However, partly probably due to current economic situation, a direct involvement faded away. More promotion and inter-ministry (science, economy, environment, ...) cooperation would be needed to enhance the use of potentials which are not small.

GB - Studies have shown that metrology research is a significant contributor to GDP through Total Factor Productivity. By increasing the amount of metrology research carried out, particularly in areas of need – as identified by the Grand Challenges, a significant positive impact can be implied. This can be enhanced by both increasing the amount of research carried out and ensuring that it is aimed at priority topics.

6.10.2 Is the EMRP Intellectual Property Rights (IPR) policy adequate?

No respondents reported any problems with the IPR policy.

DE - The EMRP Intellectual Property Rights policy is adequate. There is enough flexibility in the contracting of the JRPs.

GB - NPL believes the EMRP IPR policy is adequate, although the degree of integration of NMIs is not yet so tight that NMIs have become reliant on other NMIs IP for exploitation. No issues have yet arisen; from this we conclude that the policy has not yet been fully tested, but we do not propose any changes.

6.11 The future

6.11.1 How could joint programming between EURAMET and the EU be further developed in the future?

AT - closer cooperation to reach a status comparable to EA!

CH - Joint project activities are certainly an important element in a joint programme. However, compared to the running EMRP, financial and reporting rules have to be simplified. The overhead burden and the restrictive boundary conditions in actual projects are such that researchers may loose the motivation to participate in the programme; new innovative ideas may not be put forward. The programme should also contain elements moving European metrology to more integration:

- Joint use of expensive facilities
- Enhanced knowledge transfer among NMIs
- Inclusion of scientific and technical expertise from outside the NMI/DI community
- Coordination of national programmes (avoid unnecessary duplication of work)

DE - The EMRP may be considered as a real-life example of joint programming. This basic approach, in which the EU co-funds a programme of the Member States under Article 185, and for which EURAMET is the implementation body, should be continued.

ES - It is necessary to not restrict the participation to only NMIs and DIs and to increase the financial contribution of the Commission.

FR - Metrology is essential to support innovation, technology, quality of products, competitiveness and economy. It seems not so well known by EU. More close connection should be developed between EURAMET and EU. EURAMET should be a key organisation for the EU for metrology and quality in the frame of Conformity assessment. EURAMET can also be a pillar for technical assistance.

PL - Beyond the actual and correct policy of following the themes decided by the EU, the European Commission should support comparisons of measurement standards as a policy of international recognition.

7 Project level impact

With the A169 projects just starting, and little reporting having been received so far, it is difficult to report on actual impact at project level for those projects (Although the reader will find the aspirations documented at http://www.euramet.org/index.php?id=emrp_call_2009). This section will instead report on some of the iMERA-Plus projects (http://www.euramet.org/index.php?id=imera-plus). These were the pilot projects for the EMRP and are just completing - so impact from these should be a good indicator of what to expect from the later projects.

7.1 How effectively are the projects managed by the participants?

The 21 iMERA-Plus projects were, in general, managed well by the participants. All will complete by the end of June 2011, 10 had small extensions of a few months to their original end date but none will go beyond the original end date of the last projects to complete.

Several projects required contract changes due to a change in the way the science was delivered the most significant of these was REUNIAM, a project working to develop a primary standard for electric current based on counting single electrons, where one of the approaches planned at the start of the project was demonstrated not to meet the aims and replaced by an alternative approach. Other projects also adapted their plans to incorporate new approaches as knowledge developed over the life of the project. Small changes were required due to the availability of staff and 1 JRP-Coordinator retired and was replaced.

In general these pilot projects were a valuable training ground for the EURAMET organisation and members in running the A169 programme. EURAMET members have a wide variety of approaches to project control in their National Programmes, the diversity can be seen in the responses in section 5.4.2. Coming to a common accepted method of planning and reporting has built trust between partners that they can rely on each other to deliver things needed elsewhere in the consortium. Ordinary EURAMET "cooperation in research" projects, which have existed for many years and are unfunded, suffer from long delays. The project management structure developed for iMERA-Plus has demonstrated a better way and educated many in a more rigorous approach to project management.

While delivery to contract has been improved under iMERA-Plus there is a further stage still to be progressed. Reporting has tended to become regarded as a "tick box" exercise where many consortia believe it enough to say that they have done what they said they would do. We need to take them beyond this to report impact in the real world - what has changed outside the metrology community as a result of the work. The stories are in the projects, but they take some effort to extract.

The most significant single cause of contract changes was adapting to the emerging rules of the ERA-NET Plus scheme. Restructuring the running contracts to remove "linked third parties" and bring all partners to the same contractual level caused significant work without changing how the projects were actually delivered. Completing the Commission finance reporting, which regarded all 21 projects as a single project, was an additional overhead on the project management. These features will not be part of managing the A169 projects.

7.2 Avogadro and molar Planck constants for the redefinition of the kilogram (iMERA-Plus project T1.J1.2)

7.2.1 Background

Since the first official adoption of the metric system of units, at the end of the seventeenth century, the concept of natural and universal measurement units underpins all fields of science and engineering. Now, almost all of the base units of the International System of Units (the SI), have been defined by the fundamental constants of physics, except the kilogram, the unit of mass, which is still by definition the mass of the international prototype. This prototype, a cylinder of platinum-iridium, is kept safely at the BIPM (International Bureau of Weight and Measures), and plays a central and essential role in the SI.

A disadvantage of a unit represented by an artefact, is its vulnerability to its environment. The international prototype is suspected to have drifted by several tens of micrograms compared to the various “national copies” disseminated around the world. There is no reason to think that the mass of the international prototype is more stable that the official copies: this is the dilemma of the mass unit.

Considering the impact of atomic physics, quantum mechanics and new measurement techniques, new approaches have been proposed to face this question and to propose a redefinition of the kilogram, one of the great and major challenges of the metrology community.

The objective of the Avogadro constant project is to link the macroscopic mass, the kilogram, to the atomic mass unit via the Avogadro constant N_A, which specifies the number of atoms in one mole. The research project aims to demonstrate a direct kilogram realisation based on measuring the mass of a silicon sphere (isotope ^{28}Si) in terms of frequency and the second. Determining the Avogadro constant in this way involves making measurements of the molar mass, volume, surface, density and lattice parameter.

7.2.2 Results

Although the project seems complex, a new kilogram definition is approaching, as excellent scientific progress have been made in the European joint research project, with an accurate determination of the Avogadro constant by counting atoms in the ^{28}Si crystal, for the first time with a relative uncertainty of only 3×10^{-8}. This result will permit in the near future a comparison together with Planck constant determination via watt realisation.

The molar mass was one of the major sources of error in the determination of the Avogadro constant. Obtained from the measurement of isotope abundance ratios of the three stable Si isotopes, the molar mass has been measured with a relative uncertainty of 8 parts in 10^9, which is more than a factor of two better than expected at the outset of the project. The method developed for this purpose can also be interesting for the determination of isotopic distribution of other elements in chemistry and semi-conductor technology.

The volume of the silicon sphere is determined by measuring the diameter, of about 93 mm, by a specific double ended Fizeau interferometer. The volume is calculated from about 400 000 diameter measurements. The accuracy is still limited by the surface contamination, which implies an insufficient knowledge of the thickness and optical constant of the oxide layer, and the optical aberrations in the sphere interferometer. A new sphere interferometer has been developed and a relative uncertainty of 1 part in 10^8 is expected in the next few years on the volume. To correct the mass and volume, and reach the accuracy objective on the Avogadro constant, composition and density of the surface layer (overlaid with SiO_2 of a few nanometres thick) have to be determined.

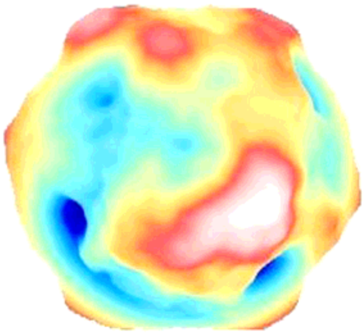


Figure 5: Diameter topography of the sphere S8. Peak to valley deviations amount to 99 nm.

The atomic volume is determined from the lattice plane spacing of the crystal lattice, measured with the aid of an X-ray scanning interferometer. A first determination of the mean lattice parameter was completed with a relative uncertainty of 5×10^{-9}.

7.2.3 Summary impact

The key achievements and the obtained result is a milestone on the way towards the realisation of the kilogram and for a new definition of the mass unit on the basis of fundamental constants.

The project, more focused on fundamental science, permits the proposal of original and new measurement techniques, algorithm and mathematical model development. Although the aim of the project was to answer the grand challenge of the redefinition of the kilogram, the project demonstrates its capabilities to realise innovative instrumentation, to implement new methods which can be applied in many different fields like analytical chemistry, semi-conductor and nanotechnology industries.

An important valorisation of the work was done through more than 34 publications and a presentation at the Royal Society Fundamental Constants event at the end of January 2011.

The project was possible because of a strong and sustainable scientific cooperation between NMIs and academic institutions.

7.3 Metrology on a cellular scale for regenerative medicine (iMERA-Plus project T2.J04)

The iMERA-Plus project REGENMED, carried out by an international consortium of four partners from three European countries, exemplifies the success that a coordination of European research facilities and capabilities can bring. The goal of the project is to develop measurement technologies and methodologies for characterising cellular properties and behaviour in regenerative medicine products and processes to support successful treatment of patients.

Regenerative Medicine replaces or regenerates human cells, tissue or organs, to restore or establish normal function[5].

In order for cells, newly grown tissue or implants to match the missing part one needs to characterise and to monitor the quality of the replacement part by accurate measurements. Successful integration of grafts and implants into the body depends, e.g., on the shape of the missing part in three dimensions but also on the surface morphology of the implant, hence sophisticated surface characterisation methods are needed. On a smaller scale, the type, shape, and viability (vitality) of individual cells grown in culture for future implantation need to be assessed and monitored. The assortment of proteins expressed on cell surfaces plays an important role, as well, and therefore needs to be known for ensuring optimum treatment success.

In each case, reliability and comparability of measurements is an important aspect, because only in this way can a consistent quality of service, both on a temporal scale and from one laboratory or clinic to another, be obtained. Preferably this is achieved by traceability of measurements to the international system of units. That is the reason why several leading national metrology institutes in Europe have teamed up in this three-year project to tackle and solve these issues. While the project is still on-going, already now it is beginning to have an impact in the regenerative medicine scene within Europe and beyond.

In this communication the technological and scientific successes and breakthroughs as such will not be addressed in detail. Suffice it to say that the project is on schedule as planned, regarding the arrival at milestones and the delivery of results. Rather, in the following the focus will be on the broader impact of the results in the medical community. “Medical Community” here is seen in a broad sense, ranging from medical practitioners to suppliers of laboratory materials and reagents to manufacturers of tissue engineered products.

A major challenge in this community is to raise awareness of the availability of modern tools and methods, followed by pilot studies and trials. This is why the REGENMED project is such a success already at this early stage: it is finding attention over the full range of key players in the field.

Some examples for the impact in the relevant community are listed here, ranging from specific invitations to give key presentations at international conferences, to participation in ISO, CEN and national standardisation bodies, to the initiation of the first international comparisons of measurement practices and results among various clinical laboratories. Not listed are the “usual” ways of communicating the results via scientific publications, appearance at technical conferences, maintaining of a website, etc. Also not listed is the impact in the sense of European cohesion that

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[5] C. Mason, P. Dunhill; A brief definition of regenerative medicine; Regen. Med. 3, 1-5 (2008)

the collaboration and coordination of activities of four major European players in this fields has already had.

- Some examples from the scientific field:
  - Various publications in refereed scientific publications
  - Numerous presentations at international conferences, for instance at the European Vacuum conference on the quantification of proteins adsorbed to surfaces, and on the use of water-soluble nanoparticles in regenerative medicine at a Microscience conference
  - Several presentations at conferences on CARS (a special laser-based analysis technique for cell components/molecules)
- Some examples from the "materials science" field:
  - Presentation at the Fraunhofer Institute for Applied Polymer Research
  - Presentation at the Fraunhofer Institute for Biomedical Engineering
  - Publication on implant biocompatibility in the journal "Materials World"
- Some examples of implementation of the results:
  - The first interlaboratory comparison of the ability of various clinical laboratories to measure the concentration of CD4 cells has been started
  - The first interlaboratory comparison of the ability of various clinical laboratories to measure the surface covering fraction of cell layers has been started
  - These two show that as a result of this project the necessity of using proper metrological quality assurance protocols is already entering proper clinical practice!
  - A dedicated session at the 2011 "World Conference on Regenerative Medicine" is devoted to the results of this project. This can be seen as a particular success regarding the creation of impact
  - Presentation at the international conference of the German Society for Cytometry
  - Presentation to the Director and other leading staff at the Berlin Brandenburg Center for Regenerative Medicine (BCRT)
  - Presentation at the Workshop on "Regenerative Medicine – clinical needs: Crossing the translation gap to the clinic" organized by the "Health Technologies Knowledge Transfer Network"/UK
- Some examples from the field of national, European, and international standardisation:
  - Participation in CEN 316 "Medical devices utilising animal tissues"
  - Presentation of the "Standard Guide for the Use of Fluorescent Materials for Tagged Cells" at the meeting of the American Society for Testing and Materials (an institution active in the organisation of voluntary standards), and in other meetings on the use of fluorophores in regenerative medicine
  - Participation in ISO "Implants for surgery – Evaluation of in vivo bone formation in porous materials"
  - Revision of British Standard PAS 63 for cell-based therapeutics

So even though the project is still on-going, its impact is already been felt in a large variety of subfields involved in regenerative medicine.

7.4 Metrology for new industrial measurement technologies (iMERA-Plus project T3.J2.2)

7.4.1 Introduction

Engineering designs for products such as aircraft and cars are becoming ever more sophisticated with aerodynamic considerations and efficiency savings at the forefront of manufacturer's concerns. While designs become more complex, manufacturing tolerances become smaller and capabilities often fall short of what is required to meet the vision of designers, meaning that what works in theory is sometimes harder to realise in practice. The lack of traceable large-scale measurements and freeform surface characterisation are two obstacles which prevent manufacturers from testing exactly what rolls off their assembly line to a suitable degree of traceability, whether it be a section of an aircraft wing or the body panel of a family saloon car.

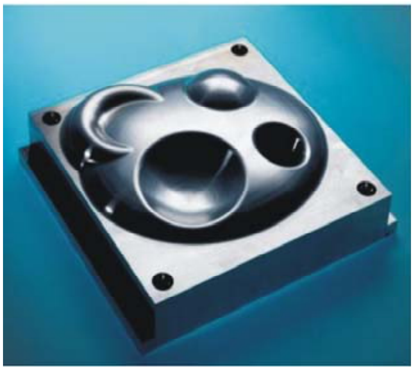
This lack of traceability is a concern for a diverse range of industries and for measurement instrument manufacturers themselves. The NIMTech iMERA-Plus JRP sought to establish a pathway to traceable measurements by first consulting industry about what was needed and then developing successful work packages to improve capabilities in dimensional metrology. Below is a selection of the key achievements of the project.

7.4.2 New measurement techniques and calibration standards

The NIMTech project developed a methodology for the use of multi-sensor systems and published good practice guides, procedures and software components that support industries such as aerospace, automobile manufacturing and ship building, as well as large engineering projects such as tunnel building. Before the NIMTech project, not only were there no internationally recognised standards in place, but also there was very little metrological support available to manufacturers wishing to use such measurement techniques. Now, there is guidance on how to position measurement sensors and errors have been mapped. The knowledge gained will be fed into standards to aid international agreement in the future.

Although Coordinate Measurement Machines (CMMs) are capable of making traceable measurements using both optical and tactile techniques, the development of portable optical systems is vital, especially in industries where heavy, bulky machines are impractical and a portable laser tracker system, for example, may be better suited to the measurement task. It is not practical to measure the entire wing of a large aircraft, even with a large CMM, so the possibility of taking the measuring instrument to what needs to be measured, and carrying out a traceable measurement in situ, is a huge step forward. A new method for verifying the performance of laser trackers has been developed that not only improves the available diagnostic information it also reduces the verification time from 6-8 hours to one. This coupled with the fact it can be implemented as an onsite test in most production environments greatly reduces downtime leads to cost savings.

Standard artefacts were produced to aid in the calibration of optical and tactile measurement systems to make traceable freeform measurements and characterise complex surfaces. This was vital, as current standards (e.g. ISO 102060 and VSI 2634) do not cover the testing of freeform measurement capabilities. A general freeform standard was produced that can be used for national and international comparisons and test specific measurement methods for their suitability at different measurement tasks. More specific standards were produced including a representation of a section of a turbine blade, such as those used for wind energy generation and in jet engines, and one for the calibration of aspherical measurements. A large (approximately one metre wide) gear measurement standard was also produced that represents a section of an involute gear, which is the most commonly used type of gear, and is the first of its kind in the world. This standard will improve traceability of measurements for complex, three-dimensional objects and aid industries that have specific measurement challenges due to large parts and complex designs.



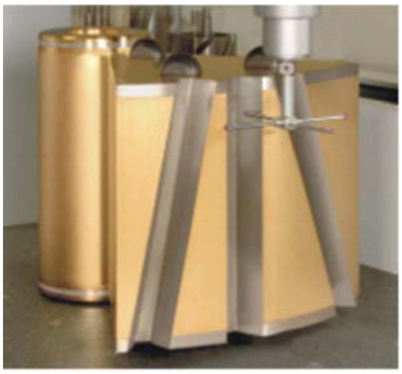


Figure 6: A freeform measurement standard and involute gear standard

7.4.3 Software

A new software validation technique has been developed which is based on test data used by measuring instruments such as CMMs. Provided was: data for different geometrical shapes, the software used to carry out the test, and an algorithm for scalar measurement of prismatic objects. An online tool hosted on PTB servers for the evaluation of CMMs and geometric evaluation algorithms has also been set up and a pilot programme was run with eight partners from industry. More data will be added to the internet aided software validation (IASV) servers over time and external clients are now able to use the service to evaluate measurement equipment.

With time, the full impact of NIMTech will be realised but the outcomes of the project are already beginning to effect change in industrial dimensional measurement. A better understanding of complex measuring systems such as multi-sensor networks has increased manufacturing capabilities; knowledge has been transferred into standards to be published in the future; traceability has been increased for measurements of complex and freeform surfaces that are so important for modern manufacturing; and European industry has been strengthened by the project and the lead of European instrument manufactures over the rest of the world has been extended. The NMIs involved in the project have also furthered their capabilities and can now offer measurement and calibration services to clients that were not available before the project.

7.5 Absolute long distance measurements in air (iMERA-Plus JRP T3.J3.1)

7.5.1 Background

Research on large scale production, global monitoring and waste management depend critically on dimensional parameters being measured or controlled to levels of accuracy that are currently unachievable over longer ranges from metres up to several kilometres. Conventionally high accuracy distance measurements cannot be directly transferred to manufacturing of e.g. aeroplanes due to the sheer size of the components. In addition to contributing to higher productivity in manufacturing, it would also benefit the safety of the general public, through better monitoring of land movements or earthquakes, thus yielding better scientific knowledge of our Earth and improving the protection of the citizens. Another important high accuracy long range length metrology application area is related to nuclear energy production and more specifically waste disposal. In order to secure the stability and integrity of storage site in bedrock, high accuracy long range length measurement are required to assess whether or not the area is stable. Although the changes in the bedrock are relatively small in the short term, the effect in the long term can be substantial. If the changes can be measured already in the early stages, future problems due to the movement could be predicted and prevented. The goal of the three year project is to reach a relative accuracy (10^{-7}; for example 0.1 mm over 1000 m) that is five times better than the currently used methods.

7.5.2 Results

The project has been done in collaboration between nine European national metrology institutes (NMI). Lively research exchange utilising facilities and equipment in another NMI made the project work and excellent results were achieved. So far five scientific publications have published in international peer-reviewed journals. In addition two workshops have been held and industrial partners have been continuously informed of the progress. Equipment for three different methods for measuring absolute distance in air have been developed and experimentally tested.

In optical distance measurements it is essential to know the refractive index of air with high accuracy. Therefore, determining the refractive index is one of the three key topics in this project. The developed measurement system is used to compensate the effects caused by the temperature and the humidity of the air, which greatly affect the refractive index. Thanks to the outstanding results obtained during the test both indoor and outdoor environment, the accuracy of the distance measurement is no more limited by the uncontrollable ambient parameters, see Figure 7. So far experimental measurements have been done for distance up to 130 metres. During the last measurement campaign in May 2011, the applicability of the method to even longer distances will be demonstrated.

The second approach developed during the project is based on the novel femtosecond laser technology. Experimental demonstration up to 100 m with relative accuracy of 10^{-8} has been achieved, which is significantly better than the original goal. The third method is based on synthetic interferometry, which has made it possible to realise a transportable instrument for long distance measurement. The system has been successfully tested at Nummela Standard Baseline over a distance of 864 m, see Figure 8. This baseline is used as the reference, because of its extreme stability and because the accuracy is the best available. This is the most prominent method so far to reach distances up to several kilometres.

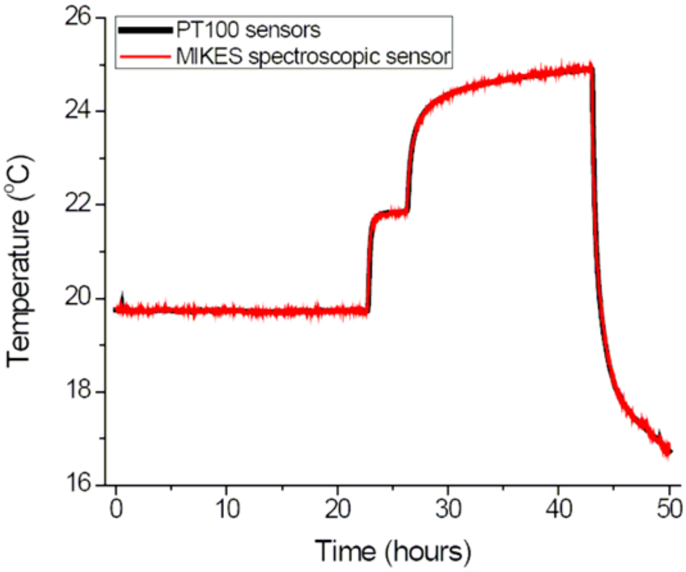


Figure 7: A temperature measurement of air over a 44 m measurement path in a laboratory environment.

(The set-point of the laboratory temperature was adjusted to induce temperature variations. The spectroscopic temperature measurement is in perfect agreement with the reference Pt-100 thermometer ensemble.)

Figure 8: Nummela Standard Baseline of the Finnish Geodetic Institute. Length of the baseline is 864 m.

7.5.3 Summary - impact

Better tools for industry and science have been developed. Long distance measurements from metres to kilometres can be done more accurately and faster. So far, techniques developed during the project have been successfully demonstrated and are of great interest to industry. In the future, competitiveness of European large-scale production industry will benefit from the results. One of the new measurement techniques has contributed to the development of a commercial oxygen analyser. Safety is also on a more solid base in the future; for example nuclear waste will be stored in a place which is measured to be stable and which can be monitored more accurately in short time.

7.6 Next generation of power and energy measuring techniques (iMERA-Plus project T4.J01)

7.6.1 Background

Modern society is built on reliable energy supply. In the last few decades mankind has become increasingly aware that energy sources are becoming scarce and also that conventional energy sources are causing very serious environmental issues, such as pollution and temperature effects on a global scale. Our future energy supply should therefore not only be reliable, but also sustainable. Such sustainable energy sources are becoming more and more available, think of wind and solar energy. However, coupling wind and solar plants to the electricity network causes several technological challenges. First, energy production becomes less and less centralised, rendering the electricity network increasingly complex. Second, such plants generate all kinds of higher harmonics, which may lead to additional energy losses, power failure or even damage to equipment.

The iMERA-Plus Power and Energy project was aimed at developing the next generation measurement techniques to tackle the above mentioned issues. Special attention was given to developing measurement techniques for actual measurements in the electrical grid, where non-optimal conditions have to be met.

7.6.2 Results

The project had several main objectives, namely to develop precision transducers for laboratory power measurements, to develop non-conventional high-current and high-voltage transducers for grid measurements, to digitise signals in the laboratory and on the grid, to condition and analyse complex AC signals for Power Quality and to implement grid based measurements.

All initial objectives have been achieved. In more detail, current convertors were developed, as well as voltage dividers for both laboratory and on-site applications. Sampling methods have now become available for power, voltage and current measurements at high levels (i.e. kV and kA). Digitisers were developed for 3-phase measurements under laboratory conditions. Specially dedicated digitizers were developed for on-site measurements in electrical substations. Also, mathematical tools have become available for complex power and quality signal analysis. A power and energy measurement guide was written specifically to be used within the context of the European electrical grid.

The tools that were developed within this project have a broad range of applications. To name a few:

- Characterisation of broad-band low-voltage power for manufacturers of measurement equipment,
- On-site power and energy measurements for utility companies,
- Determination of energy losses for manufacturers of high-voltage equipment,
- Measurement of power quality as more sustainable energy sources (wind, solar) are coupled to the electrical grid.

7.6.3 Summary - impact

Next generation techniques for power and energy measurements both in the laboratory and in the electrical grid have been developed. These will be used for measurements in the EU Smart Grids network, ensuring grid quality and stability and lowering the cost due to bad Power Quality. It is estimated that currently the costs due to the latter are 1000 M€ Europe-wide, as a result of either power failure, or additional losses, or damaging of equipment. The Power and Energy project will make it possible to lower this number in the near future.

The results that were reported could only have been achieved through intense collaboration. Every project partner contributed unique expertise. It is for the first time in the field of power and energy research that laboratories and researchers realised a common goal that they could not have reached individually. To give an example, two partners were involved in constructing current shunts, two others performed DC tests, again two others characterised the AC properties and 1 partner carried out computer modelling calculations.

Finally, it should also be mentioned that during the full duration of the project it was monitored by an active stakeholder committee of more than 20 members. This committee included standardisation bodies (including IEC), manufacturers of electrical equipment and utilities. Through the stakeholders it will be ensured that power and energy measurement guides and guidelines will be implemented for use within the European Smart Grid.

8 Summary of recommendations

	Relevant section in this report	Recommendation
1	4.5.5	To strengthen the guidance to all key partners in potential consortia and encourage them to register on EMRP Connections before the partnering conferences.
2	4.5.1 4.5.7	EURAMET members should make more effort to identify suitable referees and persuade them to register in the FP7 database.
3	4.5.7	Timings for the Review Conference should be adjusted to allow greater time for the referees with the proposers at their posters and to allow greater time for referee marking activities.
4	5.4.1	JRP-Coordinators should be warned against extending their domestic rules on project costing to the whole consortium. Organisations should be consistent in their costing approach across all projects - projects will therefore not be consistent across all partners.
5	6.4.1	That EURAMET members and their funding ministries explore mechanisms that would allow any future programmes to be more accessible to research actors other than NMIs and DIs.