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PART 21/21

COMMISSION STAFF WORKING DOCUMENT

EVALUATION

Interim Evaluation of the Horizon Europe Framework Programme for Research and Innovation (2021 - 2024)

Accompanying the document

Communication from the Commission to the European Parliament and the Council

Horizon Europe: Research and Innovation at the heart of competitiveness

{COM(2025) 189 final}

Annex 29: Evaluation of European Partnership on Metrology

Annex to the Commission's interim evaluation of Horizon Europe

Contents

The European Metrology Programme for Innovation and Research (EMPIR), established under Horizon 2020 and the Decision No 555/2014/EU[1], and the European Partnership on Metrology, established under Horizon Europe and the Decision (EU) 2021/2084[2], bring together the measurement science community and stakeholders to coordinate research. An external evaluation study[3] has been performed by consortium led by Technopolis Group Belgium, which acts as a basis for this section of the Staff Working Document.

1. Effectiveness

Achievement of the objectives

EMPIR

The specific objectives of EMPIR are included in the Decision establishing the Partnership[1]. It must be noted that actions from the EMPIR programme are still ongoing and that more results will become available after projects have been finalised in the autumn of 2024.

According to the external evaluation study, EMPIR has been successful in reaching most of its objectives[4]. For example, EMPIR has made progress towards two specific objectives of the partnership: the engagement of standardisation bodies (in the calls 2014 to 2020, EMPIR projects had made 2 316 contributions to 624 unique standard committees); and the development of a common strategic agenda, which has a thematic structure with a focus on addressing big challenges like climate change or digital transformation[4].

The external evaluation study observes that objectives related to the interactions with all European National Metrology Institutes (NMIs) and Designated Institutes (DIs) and to a turnover of at least €400M from new products and services appear to have been largely, but not fully, reached[4].

In addition to that, one of the objectives is interactions of all NMIs and DIs in the EU with EMPIR. Not all European NMIs and DIs have met this objective, as Albania, Cyprus, Latvia, Luxembourg, and Malta have not participated. Albania and Latvia were part of consortia submitting proposals for projects[4]. The external evaluation study highlighted that the absence of this group of NMIs is explained by the lack of staff and budget [4]. The average national budgets for metrology research have remained stable (in cash terms) over the decade, and programme funding has also been consistent. Regarding the objective to maintain a level of at least 50% of dedicated national metrology research investments in Europe under the coordination or influence of the programme, in the view of the external evaluation study, these shares of the national metrology budgets have remained stable at 52% (in cash terms)

[1] Decision - 2014/555 - EN - EUR-Lex
[2] Decision - 2021/2084 - EN - EUR-Lex
[3] European Commission: Directorate-General for Research and Innovation, Oomens, I., Viscido, S., Lotito, A., Knee, P. et al., Horizon Europe and the digital & industrial transition – Interim evaluation support study – Phase 2 – Horizon Europe – Institutionalised partnership report – EMPIR and European Partnership on Metrology (EPM), Viscido, S.(editor), Lotito, A.(editor), Boekholt, P.(editor) and Lebhardt, F.(editor), Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/39988
[4] EMPIR-EPM external evaluation study (2024), p. 39 and 40

over the decade, and programme funding has also been consistent. More details on the status of the objectives of EMPIR can be found in Annex 2[4].

EPM

The specific objectives of EPM are included in the Decision establishing the Partnership[2]. For EPM, Key Performance Indicators (KPIs) have been defined to monitor the progress of the objectives of the Partnership. More detail on the status of the KPIs of EPM can be found in Annex 3. The Partnership is on-going, and all the KPIs due up to mid-2024 have been met. Two organisational novelties are:

- The EPM Steering Group[2] [5], organised by the EC, is aimed at being an advisory body of the Metrology Partnership and shall give advice to the Metrology Partnership on the emerging priorities for metrology research at European level and on how to increase the impact of its research on European industry, economy and society.. Members of the EPM Steering group are experts coming from: EU Partnerships, Standards Setters, Regulators, Representatives of the Scientific Community and the Chairs of EURAMET. Minutes of the meetings are publicly available[5].
- The European Metrology Networks (EMNs), which, according to Decision (EU) 2021/2084[2], are contributing to develop new research capabilities and allow the Partnership to interact with external stakeholders in developing commonly agreed strategic research agendas. They also foster new knowledge, competences and skills across the Union, thanks to the organisation of events and sharing of information. As of July 2024, 12 EMNs have been established[6].

EURAMET operates various instruments to support capacity building[7]. EURAMET also organised specific events on regulation to gather relevant needs for the "Normative" research calls[8], and thus contribute to the design and implementation of specific standards and EU regulations[9]. As mentioned during recent consultations with major stakeholders in November 2023, EPM has good collaborations with CEN/CENELEC on the definition of potential needs for standards. Stakeholders stressed that this should have a major impact on sectors like health, where new screening methods are developed in laboratories but are not brought to the market due to the lack of standards. In addition to that, they highlighted the need to do more to ensure that outcomes of projects are reflected in future standards or regulations. In line with the objective of unleashing the potential of metrology among end-users, including SMEs and industrial stakeholders, more than 90% of the Suggested Research Topics had co-authors who were interested in using the outcomes of the projects to ensure the right exploitation

[5] Metrology - European Commission (europa.eu)
[6] EMNs Report download page (euramet.org)
[7] Capacity Building (euramet.org)
[8] Normative research calls aim at developing metrological methods and techniques required for standardisation, regulation and conformity assessment.
[9] Metrology for Energy Regulation - Open Public Consultation - Online Event (euramet.org)

activities[10]. At the moment, there are insufficient data on sales to monitor the progress towards the objective on market adoption.

Long-term scientific, societal, economic and technological impacts

EMPIR

Scientific impact

EMPIR has had a relevant scientific impact, thanks to several publications of project outputs in peer-reviewed journals. In EMPIR there have been 1689[11] publications in peer reviewed journals as of June 2024. In addition, 344 conference proceedings, 17 good practice guides, 23 technical reports, 12 books, and 51 theses have been published by the EMPIR projects. EMPIR project partners engaged with a wide range of standardisation and regulatory bodies, as detailed before. An example of scientifically impactful research is the Redefinition of the International System of Units (SI)[12]. In 2019, as an example of scientific breakthrough, after decades of laboratory work, the world's metrology community redefined four of the seven base units for the International System of Units (SI), linking them to fundamental constants of the universe[13]. EMPIR supported key European research that contributed to the SI revision and addressed the measuring challenges entailed by the SI redefinitions.

Technological impact

An example of technological impact is the EMPIR project "Precision Time for Industry"[14]. This project developed new time transfer techniques for industrial applications[15]. A correct knowledge of time is vital to modern life. Without it, energy grids, financial systems, global positioning, transport and the internet would fail. Currently, time is disseminated by radio signals or from orbital atomic clocks, which are prone to electromagnetic interference, space weather and hostile acts. A more secure system has been developed in the Project based on a protocol called White Rabbit (WR-PTP)[16]. The system acts as a backup for, or replacement of, this essential service. The techniques developed in the project have been implemented in real-life applications by several NMIs. For example, Dutch company OPNT, member of the consortium of the Project, in collaboration with SURF and the SuperGPS project, demonstrated that WR-PTP can deliver sub-nanosecond accuracy over existing telecom networks. This work helped establish WR-PTP links across Europe, including connections between VSL and ESA-ESTEC in the Netherlands. The technology's stability and scalability make it a robust backup to satellite-based timing[15]. Several National Metrology Institutes (NMIs) as of September 2024 offer time services based on the technology developed in the Project. For example, VTT MIKES (Finland) and INRiM (Italy) provide these services through partners such as Top-IX, while NPL (UK) offers NPLTime, ensuring secure and accurate UTC-synchronized time distribution for a range of applications, from 5G to smart

[10] EMPIR-EPM external evaluation study (2024), p. 41 and 42
[11] Publications Repository Link (euramet.org)
[12] SI redefinition (euramet.org)
[13] Implementing the revised SI (euramet.org)
[14] Precision Time for Industry (euramet.org)
[15] Dissemination of accurate time and frequency over ground-based optical systems (euramet.org)
[16] White Rabbit Official CERN website

grids and finance[17].The Triple-T project, which involved VSL, OPNT, and ESA, demonstrated WR-PTP's capability of 0.2 ns accuracy over a 260 km fiber link, paving the way for the Galileo G2 satellite system. This level of precision is critical for Europe's timing and navigation infrastructure, supporting innovation and resilience across industries.

Another example is the "Metrology for hydrogen vehicles 1 and 2"[18][19] projects. These projects developed new instrumentation, including capabilities of measuring hydrogen purity in real-time, at levels required by quality standards[20]. Developing precise measurement standards for hydrogen purity and flow rates ensures the safe and efficient use of hydrogen as a clean energy carrier, supporting the growth of the hydrogen economy. These projects have significantly advanced the accuracy and reliability of hydrogen refuelling stations (HRS), supporting the growth of the hydrogen economy. For instance, a company called Maximator benefited from the new measurement standards for hydrogen developed in the Project, which helped the company to validate its hydrogen dispensers, reduce production costs, and achieve international type approval[21]. This improved the billing accuracy for customers. Similarly, Resato Hydrogen Technology implemented the new measurement standards for hydrogen to ensure precise dispensing at their refuelling stations, including the highly used public hydrogen refuelling station in The Hague[22]. In parallel, AP2E developed the ProCeas H2 PURITY gas analyzer, based on knowledge gained from the project, offering real-time measurements of hydrogen purity. This tool enhances process control in hydrogen production and ensures fuel quality at HRS[20].

The "Bidirectional reflectance definitions"[23] (BiRD) project developed a metrological format for visual attributes of surface gloss[24], having applications in automotive, paint, textile, construction, and aerospace industries. The BiRD project played a key role in the creation of new standards for measuring surface reflectance and appearance, leading to the establishment of CIE TC2-85 for BRDF (Bidirectional Reflectance Distribution Function) and CIE JTC 12 for sparkle measurements. Project partner Rhopoint Instruments Ltd developed a new instrument, i-GM, which now captures a wide range of visual parameters, such as sparkle, contrast gloss, and surface texture (including defects like "orange peel"). This development, guided by metrology principles and linked to human visual perception through psychometric testing, sets a new standard for product surface appearance measurement[24].

Metrology research supports the development of smart electricity grids, including meters which provide accurate real-time data on electricity usage. The "Metrology for the next-generation digital substation instrumentation"[25] project developed metrological tools for all-digital power and energy meters,[26] facilitating better demand-side management, improving

[17] Transnational time transfer via fibre-optics (euramet.org)
[18] Metrology for hydrogen vehicles (euramet.org)
[19] Metrology for hydrogen vehicles 2 (euramet.org)
[20] Developing the technology to support hydrogen as a clean energy fuel (euramet.org)
[21] A new field test standard for hydrogen refuelling stations (euramet.org)
[22] A new flow instrument to support the use of hydrogen as a clean transport fuel (euramet.org)
[23] Bidirectional reflectance definitions (euramet.org)
[24] Improving the measurement of gloss (euramet.org)
[25] Metrology for the next-generation digital substation instrumentation (euramet.org)
[26] A new procedure for energy meters to support power grid digitalisation (euramet.org)

grid stability, and supporting the integration of renewable energy sources. In this regard, Siemens used a new Merging Unit calibration service developed by the project's partners to enhance the credibility and reliability of their substation products. Siemens improved customer confidence in its energy automation products, helping them adopt new technology for grid management[26].

As a last example, instruments for measuring ultra-high vacuums (10^{-5} to 10^{-10} Pa), used in industries such as semiconductor and solar cell manufacturing, are calibrated with ionisation gauges (IG). However, these gauges are prone to instability and can have measurement uncertainties around 10-20% - even between devices from the same manufacturer. The "Ion Gauge"[27,28] project developed a stable, transportable, ISO compliant ion gauge, with uncertainties reduced by a factor of ten (1-3%). One of the project partners commercialised this technology and won an R&D World Magazine award as one of the 100 most exciting developments in 2023[29]. As a follow-up to this project, the company INFICON used project developments to launch the IRG080, a new high-accuracy ion gauge for vacuum process applications. By improving the accuracy and stability of vacuum measurements, the IRG080 increases reliability for sectors like semiconductor manufacturing. Its design, supported by ISO standardization, allows for interchangeable gauges without the need for recalibration, reducing downtime and enhancing productivity[28].

EURAMET reported to the Commission that EMPIR projects generated 37 patent applications until March 2024. As of September 2024, no information on awarded patents has been collected by EURAMET. The European Commission recommends that information on patents is collected even after the end of the Project.

Societal impact

EMPIR is assessed to have a societal impact mainly on health and climate change.

The project "Metrology for drug delivery"[30] strives to improve the accuracy of intravenous drug delivery and feeds into update of international standards that will underpin the future validation of drug delivery devices. This project won the "Standards + Innovation 'Individual Researcher" award in 2023[31] [32].

As another example, ammonia, a highly reactive gas, has been linked to severe health effects. As it can be absorbed by components in measurement instruments, its atmospheric levels are hard to monitor accurately. Most emissions are from agriculture; thus monitors need to be field-deployable, but the data these provide can be influenced by environmental conditions. The project "Metrology for Ammonia in Ambient Air"[33] developed ammonia reference gas

[27] Towards a documentary standard for an ionisation vacuum gauge (euramet.org)
[28] A highly reproducible ionisation gauge for high vacuum environments (euramet.org)
[29] 2023 R&D 100 Award Winners - Research & Development World (rdworldonline.com)
[30] Metrology for drug delivery (euramet.org)
[31] Valid calibration of infusion pumps (euramet.org)
[32] Elsa Batista wins CEN-CENELEC Standards + Innovation award (euramet.org)
[33] Metrology for ammonia in ambient air (euramet.org)

standards for use in calibrations and in-the-field device performance assessments and upgraded the existing facilities for use with ammonia[34].

EPM

Scientific impact

The EPM is in an early stage of implementation and none of the projects launched have concluded. In EPM there have been 25 publications in peer□reviewed journals to date[11]. In addition, three conference proceedings have been published from the EPM projects and project participants have made 62 contributions or inputs to 44 unique committees of standards making bodies, predominantly at international level.

Technological impact

Even though EPM projects are at the initial phases of their implementation, some examples of potential technological impacts in the long-term can be given.

Natural gas is being increasingly replaced with renewable energy gases in the European gas networks. Through metrology research in the project "Protocol for SI-traceable validation of methods for biomethane conformity assessment"[35], standard methods for assessing the purity and calorific value of biomethane have been developed. These standards ensure that biomethane injected into natural gas grids is of high quality[36], protecting infrastructure and ensuring consistent energy output and valuation of the energy content. The project won the 'best lecture in metrology prize' at the international Gas Analysis Workshop 2024 for the description of the work done.

Battery Performance and Reliability can be improved through the new cell designs and materials. The project "Operando metrology for energy storage materials"[37] is working to establish traceable, validated and quantitative methodology for energy storage materials suitable for use in battery systems. By incorporating precise measurement techniques to monitor and optimise the internal environment of the battery cells, the project has the potential to extend the lifespan and capacity of batteries.

Societal impact

As for the technological impact, some ongoing EPM projects are expected to deliver societal impact in the long-term.

Advancements in metrology for radiation dosimetry has enhanced the safety and effectiveness of imaging procedures and cancer treatments, leading to better patient outcomes. The project "Metrology for emerging targeted alpha therapies"[38] will help generate the metrological

[34] Developing the technology to accurately measure ammonia (euramet.org)
[35] Protocol for SI-traceable validation of methods for biomethane conformity assessment (euramet.org)
[36] Presentation describing work of Metrology Partnership biomethane project wins best lecture award (euramet.org)
[37] Operando metrology for energy storage materials (euramet.org)
[38] Metrology for emerging targeted alpha therapies (euramet.org)

network needed for efficient and safe targeted administration of alpha therapies[39], improve comparability between multi-centre studies, and open new routes for the treatment of cancer.

Precise measurements of pollutants and greenhouse gases enable better regulatory practices and policies aimed at protecting public health and the environment. The project "Metrology for Earth Biosphere: Cosmic rays, ultraviolet radiation and fragility of ozone shield"[40] provides key information on the effects of cosmic rays, UV and human activities on the ozone layer. This helps Europe to make informed decisions on protecting the ozone layer, considering the related effects on human health[41].

2. Additionality

EMPIR

EMPIR does not involve further additionality requirements on top of the national contributions of members to the partnership. The total EU Contribution for EMPIR was EUR 300 million, while the public national contribution was EUR 300 million[1].

EMPIR	**Data from the Annual Report 2023**
Allocated EU contribution	€ 299 629 630
Direct leverage estimate	€ 261 847 645
Direct leverage factor	0,87
Additional leverage	n/a
Indirect leverage estimate (Economic Impact)	€ 144 630 000
Full leverage factor	1,36

Information on additional leverage has not been collected by EURAMET in EMPIR. Calculation is based on data reported in the EMPIR Annual Report 2023 and definitions can be found in Annex 1.

EPM

EPM does not involve further additionality requirements on top of national contributions of members to the partnership. The total EU Contribution for EPM is EUR 300 million[2], while the public national commitment is EUR 389 million, which means that the additional leverage faction of EC contribution is expected to be 121% at the end of the Partnership.

[39] Workshop on standards and measurements for alpha-emitting radionuclides in nuclear medicine (euramet.org)
[40] Metrology for Earth Biosphere: Cosmic rays, ultraviolet radiation and fragility of ozone shield (euramet.org)
[41] Partnership project makes progress towards protecting the Earth's fragile ozone shield (euramet.org)

EPM	Data from the Annual Report 2023
Allocated EU contribution	€ 67 698 053
Direct leverage estimate	€ 88 300 000
Direct leverage factor	1,30
Additional leverage	€ 67 102 272
Indirect leverage estimate (Economic Impact)	n/a
Full leverage factor	2,30

Calculation is based on data reported in the EPM Annual Report 2023 and definitions can be found in Annex 1. Direct leverage estimate includes fully self-funded participation in projects, contribution of associated partners to the projects, and estimated co-funding of projects. Data on co-funding of projects is not collected by EURAMET, but historical statistics on beneficiary overheads from the European Metrology Research Programme (EMRP – FP7) has been used in making the estimate. United Kingdom and Switzerland nationally funded participation are included in this category which explains higher figure than in EMPIR) Additional leverage is an evaluation of the Member State in-kind contributions to EPM.

3. Transparency and openness

Openness to newcomers and SMEs

EMPIR

The main conclusion from the interim evaluation of EMPIR[42] is that the wider measurement community was not sufficiently integrated and that the programme needed to be more open and inclusive and encourage open dialogue between the Member States' NMIs and EC services and all stakeholders, including academia, researchers and industry. A major change in response to these recommendations was the introduction of the EMNs in the second half of EMPIR, a new structure within the Partnership[6]. During EMPIR, the share of EC funding received by SMEs under H2020 was equivalent to 0.55% of the total budget, corresponding to EUR 1.6 million. The total amount of funding (including funding from Member States) that went to SMEs was equivalent to 1%. Although there was no target for SME participation in EMPIR, the number is low compared to other partnerships. In the view of the external evaluation study, this has been attributed to the fact that metrology is often long-term and related to infrastructure investments, and therefore does not match the more short-term business cycle (and funding capabilities) of SMEs[43].

EPM

The governance of the Metrology Partnership was changed from EMPIR (H2020) to EPM (HE), with a new Steering Group[5] acting as an advisory body on emerging priorities for metrology research at EU level and increasing the impact on industry, economy and society, hence making the Partnership more open to their needs. As an example of how the EPM Steering Group contributed to the openness of the Partnership, in 2022 it requested to start a

[42] Final evaluation of the European Metrology Research Programme (EMRP) and interim evaluation of the European Metrology Programme for Innovation and Research (EMPIR) - Publications Office of the EU (europa.eu)

[43] EMPIR-EPM external evaluation study (2024), p. 56

pilot trial encouraging external beneficiaries (i.e. non-signatories to the A185 agreement) to take the coordinating role in a project [44]. Normally, coordination of projects from the EPM is done by an NMI, this is not a rule but something that happens naturally in the majority of the cases. Following this request, coordination of external beneficiaries has been encouraged for calls on standardisation and fundamental metrology in 2023 and for Metrology support for Digital Transformation (DIT). EPM continued the implementation of the EMNs, allowing strategic research agendas to be developed in close cooperation with external stakeholders. In order to encourage the participation of SMEs, EPM introduced the Mutual Insurance Mechanism (MIM), which provides security against defaults in payments. Under EPM, thus far, 6% of the EC funding was received by SMEs, amounting to a value of EUR 2.2 million, this is increased compared to EMPIR.

Mechanisms to ensure openness

EMPIR

For EMPIR, 70% of the funded legal entities participating had not previously participated in EU Metrology programmes[45]. This was because in the previous programme, EMRP, no external beneficiaries were allowed. EMPIR had a bottom-up approach for the management of the calls for funding. This is done through a two-stages procedure where in stage 1 the general public can suggest a topic for research. In stage 2, applicants can send their proposals for a selected group of topics. This allowed the Partnership to be open to suggestions from a wide group of external stakeholders. Nevertheless, more could be done to advertise the opportunities for funding offered by the Partnership. Guidelines and templates are available[46] and support project partners who are new to the two-stage approach of EMPIR and the Metrology Partnership, helping them to propose ideas, join consortia and contribute to the project proposals[45].

EPM

Under EPM, considering calls in 2021-2023, the share of newcomers to the Partnership in projects was 10% of all participations, accounting for 11% of the EU funding. EPM implements the same two-stage process as EMPIR[44]. EURAMET organised several "public consultations" to orient the calls and inform the stakeholders on opportunities offered by the Partnership. Nevertheless, the view of the EC is that the bottom-up approach of the calls could be better advertised among stakeholders, to highlight the opportunity to co-define topics for funding.

Transparency

EMPIR

Following the recommendations of the interim evaluation of 2017, industrial and academic partners participated in the programming process under H2020. Strategic Research Agendas (SRAs) are being developed by individual EMNs, tailored to the needs of their communities

[44] EMPIR-EPM external evaluation study (2024), p. 58
[45] EMPIR-EPM external evaluation study (2024), p. 55
[46] Partnership guides and templates download page (metpart.eu)

of end-users, researchers and metrologists[6]. In the ex-post evaluation of H2020, it was mentioned that it was initially difficult for countries with less developed metrology institutes to be included in projects, and a lot of effort was put into capacity building[45]. These NMIs contribute to the longer-term development of research agendas through the EMNs.

EPM

The Metrology Partnership increased the coherence and links with the academic research community, industry and policy makers at large, primarily through the European Metrology Networks[47]. Through the Metrology Networks, the external industrial, academic and other stakeholders have been involved in the process of developing the Strategic Research Agendas. EURAMET and the European Commission have implemented a number of actions to consult stakeholders in the identification of research priorities through 'Open consultation events'[48], organised by the EMNs and the EPM Steering Group[5]. The EMNs also established relevant synergies with other Partnerships and HEU Missions to develop common research priorities and avoid overlaps [49].

4. Efficiency

EMPIR and EPM grants are not managed through Commission corporate tools. This creates limitations in the type and timeliness of information available to the Commission in structured way, beyond what is reported directly from the partnership[50]. The data presented in this section has been provided by the partnership ad hoc for this exercise. As of July 2024, implementation data for EPM was not yet integrated in Commission monitoring tools.

Cost-effectiveness

EMPIR

In June 2024, EURAMET stated that EMPIR had the following expenses up to end of 2023:

- Running costs (sum of all costs that EURAMET paid for the personnel, opening of calls, continuous monitoring of projects etc.) – EUR 25.438 million (requested by the Decision to be less than 5% of total partnership volume. Funded by EMPIR Members only, no EU Funding)
- Operational expenditure (sum of all the payments done by the Partnership to the projects - EU finding + MS funding) – EUR 282.934 million

EPM

In June 2024, EURAMET stated that EPM, up to end of 2023, had the following expenses:

- Running costs – EUR 3.686 million (requested by the Decision to be less than 5% of total partnership volume. Funded by EMPIR Members only, no EU Funding)

[47] European Metrology Networks (euramet.org)
[48] Communication and Outreach (euramet.org)
[49] EMPIR-EPM external evaluation study (2024), p. 31 and 32
[50] For example, information on proposals and grants is not automatically available in the Common Research Data warehouse (CORDA) encompassing all projects from EU R&I programmes. Manual integration in the system had not yet taken place at the reference date for this work.

- Operational Expenditure – EUR 37.253 million

In the view of the external evaluation study, EURAMET has improved its monitoring of in-cash and in-kind contributions of Member States; while administrative and operational burdens are a concern, the in-cash contributions have been reduced from 10% under EMPIR to 8.2% under EPM.

Time to Grant (TTG) and other indicators of operational efficiency

EMPIR

EURAMET stated that the EMPIR programme signed 241 grants between 2014 and 2020 with the following statistics:

Average Time-to-inform (TTI)	103 days
Time-to-signature (TTS)	116 days
Time-to-grant (TTG)	219 days
% below TTG target (245 days)	99%

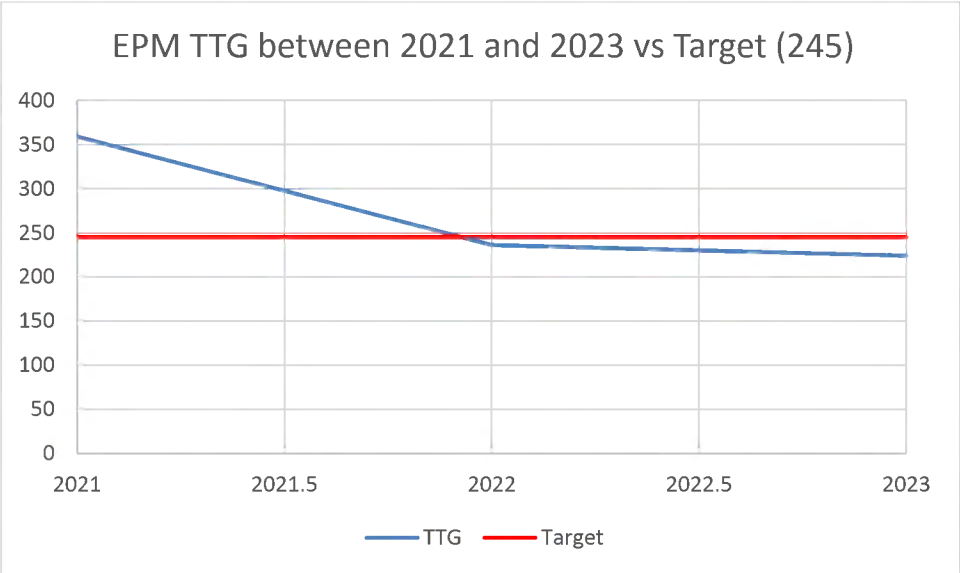
Definitions can be found in Annex 1.

EPM

EURAMET stated that, between 2021 and 2023, the EPM signed 58 grants with the following statistics:

Average Time-to-inform (TTI)	99 days
Time-to-signature (TTS)	152 days
Time-to-grant (TTG)	258 days
% below TTG target	73%

As of July 2024, the percentage of EPM projects which respected the maximum time to grant is lower than the corresponding figure for EMPIR. EURAMET stated that this was caused by a delay in the signature of the Financial Framework Partnership Agreement in 2021, the contract which allows EURAMET to sign Grant Agreements with beneficiaries. For calls 2022 and 2023, the average TTG met the target, as shown in the graph below.



EURAMET did not provide any information on applicant costs and/or administrative burden, because they have not asked applicants and beneficiaries of EMPIR and EPM to provide such data. The Commission recommends that EURAMET prepares a survey to be circulated to beneficiaries, in order to assess this point.

5. Coherence and synergies

Complementarity with relevant regional, national and EU policies/programmes

EMPIR

In order to tackle the challenges of the EU at that time, the targeted programmes in EMPIR were: Environment, Energy, Fundamental Metrology, Health, Industry, New Technologies, Normative, Capacity Building, SI Broader Scope and Support for Networks[51]. A major change initiated in EMPIR was the introduction of thematic programme calls on the Green Deal on Health and on the Digital Transformation[49]. EURAMET stated in July 2024 that in EMPIR, approximately 180 projects covered areas linked to EU priorities and programmes such as: Health, Digital Transformation, Radiation Protection, Agriculture, Energy grids, Quantum, Space, Maritime and Fisheries, Climate and Environment, Hydrogen and Chips[52]. As an example, EMPIR research in advanced measurement techniques has resulted in an end-to-end traceability chain (from European National Measurement Institutes to end-users)[53]. In addition to that, EMPIR (and now EPM) Partnership Members are owners of the National Metrology Programmes, facilitating synergies and complementarities at Member State level.

EPM

In order to be consistent with the Decision[2], stating that EPM should contribute to the realisation of the Union's objectives and policies and to tackle global challenges, targeted programmes are: Industry, Research potential, Green Deal, Health, Integrated European Metrology, Regulation, and Pre- and Co-normative research. EPM Calls between 2021 and 2024 addressed areas such as Health, Digital Transformation and Industry[55]. EURAMET stated in July 2024 that, for EPM, approximately 80 projects are covering areas linked to EU priorities and programmes such as: Health, Digital Transformation, Radiation Protection, Agriculture, Energy grids, Quantum, Space, Maritime and Fisheries, Green Deal, Chips, and Single Market[54]. For the calls from 2025 to the end of the Partnership in 2027, these areas are expected to be addressed again [55]. The Partnership also left two undefined areas in the schedule, one in 2026 and one in 2027, to potentially address new priorities defined by the Commission 2024-2029. In addition to that, the Normative calls ensured a direct contribution to regulation and standardization activities at EU and regional level. EURAMET organised consultation events on different topics and is envisaging further similar workshops in the future.

[51] About EMPIR and call plan (euramet.org)
[52] EMPIR Calls and Projects (euramet.org)
[53] PERFORMANCE OF EUROPEAN PARTNERSHIPS: Biennial Monitoring Report (BMR) 2022 on partnerships in Horizon Europe – Page 91
[54] Metrology Partnership Calls and Projects (euramet.org)
[55] EPM Plan for Calls (metpart.eu)

Metrology contributes to the functioning of the European Single Market[56,57]. Metrology provides the measurement standards and traceability[58] that enable reliable measurements in trade, ensuring that consumers receive the correct amount of goods for their money. This applies to everything from grocery items to fuel and electricity, where precise measurements are crucial. Overall, metrology influences everything from daily commerce to manufacturing, global trade and high-level scientific research[59]. To improve synergies in this field, EURAMET and other actors of the European Quality Infrastructure[60] recently established a European Quality Infrastructure (QI) Network[61] to jointly address aspects including metrology, standardization, accreditation, and conformity assessment.

On the regional development side, one complementary action is the construction of a new campus for the Polish NMI, GUM[62], primarily funded by the European Regional Development Fund (€32M). This investment will give GUM improved opportunities to contribute to research linked to EU priorities e.g. through EPM.

Synergies with other parts of the Framework Programme

EMPIR

As highlighted in the external evaluation study, during H2020, links were established with the EU Quantum and Graphene Flagships, forming the basis for deeper and more consequential subsequent relationships within the EMNs[49]. Collaborations were focusing on the definition of research priorities to be also implemented in EMPIR in order to ensure that the activities in the two Programmes were complementary. For example, the relationship with the members within the Quantum Flagship has evolved into deeper relationships within the EMN in Quantum Technology.

With EMPIR, synergies with standardisation bodies have been created, which continued in EPM[63]. As an example, the STAIR-EMPIR Platform ensures a mutual exchange of information between EMPIR (now EPM) and CEN-CENELEC to allow the Partnership to actively contribute to the creation of new standards with the outcomes of the funded projects. This is based on a signed an MoU between CEN-CENELEC and EURAMET in 2010 and renewed in 2015[64] [65].

EPM

At the start of Horizon Europe, multiple interconnections were identified between the (candidate) European Partnerships, both within and among the clusters. It was expected that

[56] Legal metrology - European Commission (europa.eu)
[57] Single Market | WELMEC
[58] The Importance of Measurement Standards and Traceability - Calibrate
[59] Ensuring Quality to Gain Access to Global Markets (worldbank.org)
[60] ECE_TRADE_478.pdf (unece.org)
[61] CEN, CENELEC, EA, EURAMET, and WELMEC join forces to reinforce and promote the European Quality Infrastructure - CEN-CENELEC (cencenelec.eu)
[62] The Campus Project - National - Central Office of Measures (gum.gov.pl)
[63] EMPIR-EPM external evaluation study (2024), p. 49
[64] Cooperation Agreement between CEN-CENELEC and EURAMET
[65] STAIR-EMPIR: Joint initiative of CEN-CENELEC and EURAMET continues

partnerships developing cross-cutting technologies and methods, such as EPM, could team up with partnerships in industry or societal application areas (e.g. health, mobility, energy and agriculture)[49]. Looking at the progress that was made in the first two years of Horizon Europe, the external evaluation study confirmed that major improvements have been made in EPM as compared to EMPIR, when it comes to connections to other partnerships, in particular within Cluster 4[49]. This has been driven by the new EPM Steering Group, which has worked to facilitate and improve connections to other European partnerships. Representatives of four other Partnerships are members of the EPM Steering Group: the Key Digital Technologies JU, the Clean Hydrogen JU, the Built4People (B4P) co-programmed partnership and the Made in Europe Partnership[49]. These members are expected to rotate soon and be replaced by representatives of other four European Partnerships. In context of the Quantum Flagship Initiative, EURAMET is in discussions with DG CNECT on the implementation of the measurement and testing pillar of the Quantum Flagship.

The EURAMET EMNs facilitate stakeholder engagement[6]. While most interactions are informal, some stakeholders are connected to the EMNs formally via memoranda of understanding (MoUs), letters of intent and appointments to the EMNs' stakeholder advisory boards.

The EMNs have established MoUs with:

- ICRP[66] (the International Commission on Radiological Protection is an independent Registered Charity, established to advance, for the public benefit, the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionising radiation. Public radiation authorities, hospitals, academia and research centres are part of the group.)
- Hydrogen Europe and Hydrogen Europe Research (Association of the Clean Hydrogen JU)
- GERG[67] (the European Gas Research Group, along with its member organisations, work to develop innovative solutions which place the gas infrastructure at the heart of the energy system. Industry, academia and research centres are represented in the group.)
- VAMAS[68], (the Versailles Project on Advanced Materials and Standards supports world trade in products dependent on advanced materials technologies, through International collaborative projects aimed at providing the technical basis for harmonized measurements, testing, specifications, and standards[6] [69], Ministries, industry, academia and research centres are represented in the group and working in the projects.)

[66] ICRP
[67] Gerg - The European Gas Research Group
[68] Versailles Project on Advanced Materials and Standards (VAMAS)
[69] EMPIR-EPM external evaluation study (2024), p. 33

Some EMNs build synergies with European Partnerships to co-create research priorities e.g. with Clean Hydrogen JU, EURATOM, and the Quantum Flagship Initiative[6]. Further information on the synergies established (as stated by EURAMET in July 2024 in a report on the EMNs[6]) can be found in Annex 4.

6. EU added value

EMPIR

The use of programme and partnership models supported by the European Union (A185) has provided the metrology community with a framework for increased coordination and collaboration[70].

Importantly, the Art. 185 approach have provided EURAMET with a well-defined administrative structure to support cross-NMI working, manage European research funds and coordinate national activities. In doing so, this increases coherence and reduces fragmentation of metrology research at the European level[70]. The H2020 funding has underpinned these developments; not only it acted as a catalyst and motivator for European collaboration and coordination, but it also enables the European NMIs to increase the range and relevance of their research, while continuing to maintain the fundamental underpinnings of the national and international measurement system[70].

The need for a proactive approach to ensure continued and, ideally, greater integration within the Metrology Community remains. In the view of the external evaluation study, developing and agreeing a European level strategy and the mechanisms to implement it, both to support coordination and jointly develop new metrology capabilities (at the cutting-edge and across Europe), takes considerable time and resources and is unlikely to happen without EU support[70]. The partnership's view is that without a structured European Collaboration on Metrology through the EMPIR Programme and Metrology Partnership, activities would be fragmented and efforts duplicated across Member States. This would lead to a lack of impact at the EU and global level, as the scale and complexity of metrology require investments that go beyond the core research budgets of the national metrology institutes. The excellence required for research and development of cutting-edge metrology solutions is spread across national borders and hence cannot be attained at national level only.

EPM

The EPM continued the work of EMPIR in ensuring coordinated research for metrology in the EU. In addition to that, the EMNs, established at the end of EMPIR and fully implemented in EPM, have a contribution in boosting the coordination at EU level of the activities on Metrology[71] [6]. The EMNs not only allowed the NMIs to collaborate on a specific domain and to develop a common research agenda, but also allowed for better and increased interactions with external stakeholders. This ensures that the Partnership responds to the needs of industry and EU priorities, and also raises awareness on the importance of metrology and the

[70] EMPIR-EPM external evaluation study (2024), p. 45
[71] EMPIR-EPM external evaluation study (2024), p. 48

collaboration with the NMIs[6]. The EPM Steering Group also contributes to ensure that the NMIs are working on the right priorities, thanks to interactions with standard setters, international organisations and other European Partnerships.

7. Relevance

Relevance to challenges and needs

EMPIR

In the view of the external evaluation study, the objectives of EMPIR were aligned with almost all the "Leadership in enabling and industrial technologies" (LEIT) objectives under H2020, particularly when it comes to the support of innovation, industrial uptake and standardisation through joint research projects and bringing parties together to construct common agendas. Only the objective of LEIT ICT to 'increase collaboration around common, open technology platforms' is not explicitly covered in EMPIR's objectives[72].

EPM

In the view of the external evaluation study, EPM is in line with three impact dimensions of HE[72]:

Strategic Autonomy/global positioning: when it comes to metrology, Europe has a strong position, provided that there is collaboration between Member States. Metrology is an enabler of strategic autonomy but there is an investment gap between Europe and its global competitors. Placing the EU on a level playing field with its competitors is amongst the objectives of EPM.

Industrial competitiveness/digitalisation: Metrology Institutes have traditionally been very closely tied to industry and industry needs. The NMIs offer traceable calibration services to industry and calibration laboratories, develop new measurement methods and devices, and develop measurement infrastructure to enable industry to improve their products and production systems. The EMNs are particularly relevant to industrial competitiveness and the digital transformation.

Sustainability/Green Deal: The first EMNs that were started were almost all focused on sustainability and the Green Deal. Six out of the twelve current networks are particularly relevant to the Green Deal.

Flexibility

EMPIR

In EMPIR, the bottom-up approach in the Work Programme, whereby the general public can suggest research topics in pre-defined areas, ensured a good flexibility of the Partnership to adapt to current needs [72]. In fact, al selected research topics for Stage 2 are coming from the needs suggested in Stage 1 by the general public. Applicants can find all the relevant

[72] EMPIR-EPM external evaluation study (2024), p. 27 and 28

information on Stage 1 and 2 of the calls in the yearly Work Programme (WP) or the applicants webpage[46] [73].

EPM

The EPM continued with the bottom-up approach that had been adopted in EMPIR. EURAMET stated that Call Scopes for the Targeted Programmes were developed by the Committees and complemented by Orientation Papers, describing topical stakeholder needs that should be addressed by the metrology community. The EMNs and the EPM Steering group are also working to ensure that research needs contained in Orientation Papers and strategic documents are always updated and reflecting needs of the EC and other stakeholders.

8. Directionality

EPM

In the view of the external evaluation study, EPM is in line with the impact dimensions of HE Cluster 4, and it is focused on today's global challenges[74] [2]. The fiche in EPM of the 2022 Biennial Monitoring Report on European Partnerships states that it delivers on global challenges, supports the European Green Deal, and underpins innovation in industry[75]. The strategic research agenda "EURAMET 2030 Strategy"[76] also mentions the Sustainability and Energy challenges (with impacts on sustainability/green deal); and Innovation, with a focus on European Industry. The main process in place to deliver on this vision is through the EMNs. The EMNs are established in highly competitive areas and engage with stakeholders to ensure 'state-of-the-art metrology capabilities' that are taken up by innovators[74].

By increasing the role of metrology in the design and implementation of regulation and standardisation, EPM also aims to underpin public policies[74]. The EMNs also develop their own strategic research agendas. Furthermore, different call themes were scheduled under EMPIR and EPM that should ensure the delivery of results on these global challenges and competitiveness. As mentioned, EURAMET also organised several public consultations to ensure that the priorities addressed by the Partnership are aligned with the needs at EU level, including competitiveness, and addressing the global challenges. The Biennial Monitoring Report Survey Results of 2023 note the proportion of the total partnership budget that is invested into EU priorities[71]. In general, EPM seems to be on track in reaching its objectives and contribution to the Green Deal, and Digitalisation seems most fitting for the partnership[74]. In the view of the external evaluation study, given the horizontal nature of metrology, additional objectives for Resilience could be considered for the next FP[74].

[73] EPM WP 2024
[74] EMPIR-EPM external evaluation study (2024), p. 50
[75] PERFORMANCE OF EUROPEAN PARTNERSHIPS: Biennial Monitoring Report (BMR) 2022 on partnerships in Horizon Europe – Page 245
[76] Strategy 2030 (euramet.org)

9. International positioning

EPM

The Partnership has built synergies beyond the EU, ensuring the participation of international bodies in the governance of EURAMET. For example, the BIPM (the International Bureau of Weights and Measures) is a member of the EURAMET Research Council; and the World Metrology Organisation (WMO) is a member of the EPM Steering Group[77]. While connections with WMO were already established under the FP7 partnership, EMRP, this shows that recently established governance bodies have close connections to relevant stakeholders[77]. Furthermore, several EMNs also have global stakeholders as liaisons, which are established on an informal or formal basis. Examples of liaisons are the International Consortium for Harmonization of Clinical Laboratory Results (ICHCLR), the International Atomic Energy Agency (IAEA), BIPM, the World Health Organisation (WHO), the International Committee for Radiological Protection (ICRP), and others[77].

Projects from EPM also collaborated with partners outside the EU. As an example, the project "Metrological framework for passive radiative cooling technologies"[78] is working to develop a metrological framework to classify and compare Passive Radiative Cooling (PRC) materials. These materials provide an emerging technology that can cool to sub-ambient temperatures even in direct sunlight, and could be an efficient alternative to conventional systems, saving up to 80 % of cooling-related electricity. SPACECOOL INC in Japan has developed a PRC material known as SPACECOOL film[79]. The company will provide the material and will collaborate with the consortium towards the development of characterisation methods, demonstration tests and life cycle assessments for PRC materials.

In conclusion, EPM has a good international positioning and connections with all relevant international metrology bodies. In the current political climate, it is important that the EPM continue to invest in maintaining these relationships, through for example engaging with them in international networks, representation in governance structures and collaborating in projects and through EMNs[77].

10. Phasing-out preparedness

EPM

The EMNs are intended to be a central feature of a sustainable and more integrated metrology infrastructure in Europe, providing a mechanism to coordinate NMIs/ DIs and act as an established interface with the industrial, public and research communities they serve[80]. They are a coordination structure within the governance structures of EURAMET and will be led and driven by its members, the NMIs[80]. It is a structural mechanism that, if used well and engages with non-NMI /DI communities across Europe (i.e. the users of metrology), can play a central role in identifying metrology needs and collectively delivering solutions[80]. However,

[77] EMPIR-EPM external evaluation study (2024), p. 52 and 53
[78] Metrological framework for passive radiative cooling technologies (euramet.org)
[79] EURAMET project on passive radiative cooling technologies collaborates with SPACECOOL in Japan
[80] EMPIR-EPM external evaluation study (2024), p. 60

these networks have a significantly different structure from that of the previous partnerships, and while they are important to the 'phasing-out' strategy, they are costly to initiate and implement. In the view of the external evaluation study, while the EMNs are directly funded by Member States, this funding is still catalysed and incentivised by the EC Institutionalised Partnership model, and the EMNs are likely to be at risk without this model as an underpinning structuring and funding mechanism[80].

During a Workshop on the future of Metrology in Europe, stakeholders highlighted that a structured EU support is needed in the future. In February 2024, the European Commission organised a further workshop with all the EMNs' Chairs. The discussions highlighted again the importance of the EMNs to a phasing-out strategy; and they have been highlighted as a key actor for a potential evolution of the current partnership.

Annex 1 – Glossary and definitions

GLOSSARY	
CIC	Coordination of Impact and Communication
DI	Designated Institute
DIT	Digital Transformation
EMN	European Metrology Network
EMPIR	European Metrology Programme for Innovation and Research
EPM	European Partnership on Metrology
FFPA	Financial Framework Partnership Agreement
GRD	Green Deal
JRP	Joint Research Project(s)
NMI	National Metrology Institute
NRM	Pre- and Co-Normative
PRT	Potential Research Topic
RPT	Research Potential
SRT	Selected Research Topic
TC	Technical Committee

Term	**Meaning or definition**
Direct leverage	Difference between a project's total costs and the EU contribution given to the project.
Direct leverage factor	Ratio of the direct leverage and the EU contribution. It is related to the 'Funding rate' (see the definition below) via the following formula: $Direct\ leverage\ factor = \frac{1}{Funding\ rate} - 1$
Funding rate	Ratio of the EU contribution to a project and project's total costs.
Additional leverage	Additional leverage is additional activities or investments triggered by the partnership and can include private investments or public investments mobilised from other EU or national programmes.
Average Time-to-inform (TTI)	Time from call closure to announcement of results. Target 5 months which is 153 days
Time-to-signature (TTS)	Time from invitation letter to grant agreement signature. Target 3 months which is 92 days
Time-to-grant (TTG)	Time from call deadline/closure to grant agreement signature - equivalent to TTI + TTS. Target 8 months which is 245 days
% below TTG target	% of projects with TTG less than 245 days Time-to-grant

Annex 2 – EMPIR – Status of Objectives as reported in the AAR2023

1.1 At least 400 M€ of European turnover from new or significantly improved products and services that can be attributed to the research activities of EMPIR and its predecessors

EURAMET conducted surveys of industrial participants in EMRP projects and developed impact case studies. For EMRP 352.8 M€ is directly attributable to the programme. This figure covers the industrial participants who participated in all EMRP projects. In addition, the new products sold will contribute to economic benefits for many of the end-users. Up to now we identified 159,70 M€ from call 2014, 2015 and 2016 projects directly attributable to the EMPIR programme.

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

All EMPIR proposals are required to specify which documentary standards and standards developing committees and working groups they will engage with. This engagement is tracked and reported by the EMPIR reporting processes. During the proposal phase 95 % of the JRPs of the EMPIR calls (2014 to 2020) planned to have some input to standardisation (230 JRPs/JNPs/SIPs for a total of 241 JRPs/JNPs/SIPs). After the reporting periods and the final reports of call 2014 to 2018 to the end of 2023, the calls 2014 to 2020 EMPIR projects had made 2316 contributions to 624 unique standard committees.

1.3 Maintain a level of at least 50 % of dedicated national metrology research investments in Europe being coordinated or influenced via the programme

In 2005, the 14 states proposing the iMERA project (a predecessor of the programmes) assessed their joint national research budget as 165 M€ per year and that up to half of that value could be subject to a joint prioritisation process. This appears to be the origin of the 50 % concept.

For 2015, 18 states participating in EMPIR have assessed their joint national research budget as 166 M€. This includes most of the largest participants and is unlikely to increase significantly when further data is received.

The annual value (to the NMIs and DIs) of the research projects commissioned by EMPIR is 68.571 M€ (30 M€ from the EU and 38.571 M€ as in kind funding from the national budgets). This is similar to the long term annual rate across the programmes (iMERA-Plus, EMRP, EMPIR).

If the objective is to *maintain* then this is clearly achieved – the average national budgets for metrology research have stayed stable (in cash terms) over the decade, the programme funding has also been consistent.

However, demonstrating a figure of 50 % is more difficult, we need to be very careful which ratio we are talking about:

1. The percentage of the national budgets that is coordinated by the programmes (in the sense that the national budget is diverted to the in-kind funding) is 23 % (38.571/166).

2. The value of the total EMPIR budget compared to the national metrology research budgets over the same period (7 years) is 52 % (600/(7*166)).

Analysing the information on a country basis only adds confusion. Where countries don't use FEC to assess their national budget they can appear to use a significant part of their total national funding in the in-kind commitment (Türkiye 75 %, Slovenia 116 %, Poland 73 %). For those with reliable FEC figures, Sweden commits the smallest at 12 %, Germany 16 %, France 18 %, The Netherlands commits the largest at 68 %.

Further numerical analysis is unlikely to give greater insight. Simple messages to take forward are:

- About a quarter of the national metrology research budgets is used as in-kind funding to EMPIR.
- The metrology research funded through EMPIR is about half the value of the metrology research funded by the combined national metrology research budgets.

Understanding the differences between these two statements is important when considering other indicators e.g. information from the EMRP on number of publications from NMIs supported by the programmes.

For the final evaluation, a survey should be done on which nationally funded projects are *influenced* by the programme, i.e. either done as preparation for an anticipated EMPIR project or further national work exploiting the outputs of an EMRP/EMPIR project. This will enable a more comprehensive evaluation of this objective.

1.4 All European NMIs and their designated institutes interact with the programme

All Euramet members have a place in a funded JRP except:

1.4.1 Albania

They had an ESRMG in EMRP and were co-authors on two PRTs in 2016. An RMG was unsuccessful in 2016 due to insufficient common language between the guest worker and host. In addition, Albanian NMI submit one PRT in 2017, but was not selected for prioritisation.

1.4.2 Cyprus

Cyprus has not yet engaged with the programme. It has appointed a delegate to the General assembly but does not take part in any other parts of EURAMET.

1.4.3 Latvia

Latvia was a co-author in one PRT in 2016.

1.4.4 Luxembourg

The Luxembourg NMI consists of one person who claims to have no time to engage with us – not even to attend HI-CB training.

1.4.5 Malta

The past head of the Malta NMI was heavily engaged with EURAMET – a member of the Board of Directors. But with just 3 staff, concentrating of providing commercial services, engagement with the programme was not their priority, but they could manage to take part in Capacity Building activities so far.

In general, the thing limiting engagement from these countries is lack of staff and particularly money to fund the travel to attend training events.

1.5 European leadership in at least 20 % of international metrology committees

Of the 95 chairs and vice chairs of the working groups of the CIPM Consultative Committees, 42 come from European NMIs and DIs.

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

EMPIR and its precursor joint programming activities (EMRP, iMERA-Plus and iMERA and MERA) have been on a journey towards closer integration of metrology research in Europe based on a common research agenda that drives and guides the collaborative pan-European research. EMRP research was guided by the research priorities identified during iMERA and similarly, during EMRP, EURAMET and its members developed a European Strategic Research Agenda (SRA) for the EMPIR period (http://www.euramet.org/research-innovation/sra-survey/).

A key element of the common research agenda for both EMRP and EMPIR is a thematic structure with a strong and direct focus on metrology to address the grand challenges rather than the traditional approach to metrology research focused on technical areas and/ or SI units. EMPIR calls are designed around the themes (referred to as TPs (Targeted Programme) in EMPIR) and the call scopes are based on the content of the SRA. The first stage of a two-stage proposal selection process ensures that proposed research topics align with the SRA and the call scopes.

The challenged based themes: energy, environment, health and industry are targeted at the needs of measurement uses in these areas be they public agencies seeking solutions, policy-makers and regulators seeking to design and implement solutions, businesses seeking to provide solutions or the research base. A key route to impact for the better measurements enabled by metrology research is to embed new accurate measurement methods in documentary standards and to improve the impact of metrology research, a new TP has been implemented in EMPIR to specifically to address the needs of standards organisations (CEN, Cenelec, ISO, etc.).

In addition to the challenge-oriented research EMPIR has two themes focused on longer-term more basic research to ensure the underpinning metrology system will meet society's future measurement needs. This research supports the development of the underpinning SI system of units (SI Broader Scope theme) as well as more exploratory research in the Fundamental theme.

Under EMRP 78 % of the research funding was directed to challenge-oriented themes and in EMPIR 71 % of the research funding is directed to the themes Health, Energy, Environment and Industry.

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

- The Industry calls (in 2014, 2017 and 2020) had a total budget (EU contribution) of 70.2 M€. This is 23.4 % of the 300 M€ total.
- Of all selected projects, 17 % by number of projects and 23 % by value have been for the industry theme.
- Of the contracts issued, 7,5 % of the estimated costs belong to industrial beneficiaries, 60 % of these are funded and 40 % are unfunded.
- Of the contracts issued, 13 % of the legal entities involved are industrial.

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

Proposers are asked to estimate the percentage of effort in their proposals directed towards normative activities. This is then moderated by the MSU during negotiation to ensure the data is consistent with the activity descriptions. For the contracts issued, the estimate is that 10 % of the effort is dedicated to normative research.

Call year	Percentage of Standardisation /participation	Percentage of pre and co-normative participation	Amount of NRM projects in that call year
2014	15,3%	n/a	€ -
2015	17,4%	4,8%	€ 1.869.547,01
2016	35,3%	10,5%	€ 4.985.021,67
2017	19,7%	9,8%	€ 4.617.929,16
2018	23,9%	11,0%	€ 4.889.963,97
2019	31,4%	14,8%	€ 6.689.065,05
2020	24,8%	13,6%	€ 5.901.057,90
Sum for all in %	24,8%	10,0%	€ 28.952.584,76

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

Headcount information will not be available for EMPIR projects until they submit the "H2020 Questionnaire" at first periodic reporting. However, we do have estimates of person-months that can be compared between the programmes. The external participation in EMRP was

concentrated in long REG contracts – typically one person providing 36 months. The external participation in EMPIR is more likely to be more people providing less months each, so it is highly likely that the objective will be met.

The REG contracts in EMRP (the route for funding non NMI/DI scientists in that programme) funded a total of 5740 months.

Of the EMPIR contracts issued so far, the external funded participants estimate the funded effort to be 11.184 months. This represents an increase of 1,9 times the months in EMPIR compared to EMRP.

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

Capacity Building is supported through a range of training activities and a Mobility Grant scheme, all funded from the cash contributions. Despite much work on seeking routes to influence the direction of structural funds, no common systematic approach has been discovered.

From an initial survey we have identified some 17 M€ of structural funds directed to metrology infrastructure. Additionally, nearly 10 Mio € budget have been used in the RPT calls from 2014 to 2019.

1.11 Strengthen European leadership through EURAMET and foster global cooperation. It should lead to at least two structured cooperations with major metrology actors outside Europe (e.g. US, Canada).

Forum on Metrology and Digitalisation (International)

The Forum Metrology and Digitalisation is dedicated to advice CIPM in the SI Digital Framework and the wider implications of the global digital transformation for metrology and for the international Quality Infrastructure. It also contributes to harmonize internal processes related to digitalization between NMIs, CCs, RMOs, and BIPM headquarters. Furthermore, it acts as a forum to exchange information and to create synergies and opportunities for collaboration in this field, including, but not limited to, liaison with International QI Organizations, relevant International Organizations, international Science organizations, relevant industry associations, and further relevant stakeholders in digitalization. Forum on Metrology and Digitalisation is chaired by Prof. Ullrich from PTB, a member institute of EURAMET and the EURAMET M4D working group (Metrology for Digital) has contributed to the development of the forum, ensuring standardization and effective adaptation to evolving technological landscapes.

CIPM Sectorial Task Group on Climate Change and Environment (International)

The CIPM Sectorial Task Group on Climate Change and Environment (CIPM-STG-CENV) plays a crucial role in addressing the challenges posed by climate change through the lens of metrology. Chaired by D. del Campo Maldonado from EURAMET, and building on the work

of the EURAMET EMN on Climate and Ocean Observation, the Task Group is actively working on implementing the recommendations arising from the CIPM and the BIPM-WMO Workshop on Metrology for Climate Action, held in September 2022.

The Task Group focuses on two primary themes: "Metrology in support of the physical science basis of climate change and climate observations" and "Metrology as an integral component of operational systems to estimate greenhouse gas emissions based on accurate measurements and analyses." While significant progress has been made in the former, particularly in supporting the physical science basis of climate change, there is ongoing work in addressing the latter, especially concerning greenhouse gas (GHG) emissions.

The significance of the CIPM-STG-CENV is underscored by the increasing global focus on greenhouse gas emissions monitoring. The establishment of initiatives such as the WMO's Global Greenhouse Gas Watch (GGGW) and national efforts, like the US Greenhouse Gas Center, emphasize the growing demand for gas calibration standards. The metrology community, in collaboration with the atmospheric monitoring community, is poised to contribute significantly to meeting this demand. The CIPM-STG-CENV's work aligns with these developments, aiming to enhance metrological support for climate-related initiatives and advance the global understanding of greenhouse gas dynamics.

Annex 3 – EPM – Status of KPIs as mentioned in the AAR2023

Objective	KPI Definition/ proposed target	KPI achievement
1. To develop, by 2030, new research capabilities which are built within the framework of new European metrology networks (EMN) and which perform in terms of calibration and measurement capabilities at least equally to the leading metrology institutes outside the Participating States	**By mid of 2024**: 1.1 The EMN landscape will have been completed through strategic consideration of topics where the NMIs and DIs most benefit from coordination, complementarity, and joint research capabilities. At least 12 EMNs will have been launched. 1.2 Deliver a report on the number of EMNs and their joint research capabilities including staff effort and shared infrastructure. **By the end of 2030**: 1.3 At least 9 of the EMNs will demonstrate measurement capability at the top international level.	**Status end of 2023:** 1.1 Up to end 2023, 12 EMNs have been launched: Advanced Manufacturing, Climate and Ocean Observation, Energy Gases, Mathematics and Statistics, Pollution Monitoring, Quantum Technologies, Radiation Protection, Safe and Sustainable Food, Smart Electricity Grids, Smart Specialisation in Northern Europe, and Traceability in Laboratory Medicine The EMN for Clean Energy has been approved and is building up their website at the moment. 1.2 Each EMN's respective SRA has been published on their websites. A draft report has been delivered to the Commission for their review in September 2023. 1.3 The measurement capabilities are under development at the moment.
2. To support, by 2030, sales of new innovative products and services through the use and adoption of the new metrology capabilities in key emerging and	Every year: 2.1 The number of participants from industry and early adopters of the developed technologies in JRPs to be at least at the level	**Status end of 2023:** 2.1 The number of participants from industry and early adopters of the developed technologies in JRPs as of the end of 2023 is detailed below, and comparable figures for EMPR are given as reference. As the number of projects is different, the average number of participants per project is used to assess if the KPI is

Objective	KPI Definition/ proposed target	KPI achievement
enabling technologies	of participation in the last EMPIR comparable Target Programmes (Industry, Health, Normative, Green Deal "Energy-Environment") The number of participants in JRPs as regards digital calls should be included in the report.	met.

2. To support, by 2030, sales of new innovative products and services through the use and adoption of the new metrology capabilities in key emerging and enabling technologies	By mid of 2024 2.2 Deliver a report on the trends in European turnover from new or significantly improved products and services that can be attributed to the research activities of the partnership and its predecessors by TP. 2.3 At least 40 % of the collaborators81 in joint research projects should be profit-making entities. Every year from 2026 onwards: 2.4 An average of at least EUR 50 million of European turnover from new or significantly improved products and services should be demonstrated to result from the research activities of the Partnership. 2.5 At least 40 % of the collaborators in joint research projects should be profit-making entities.	**Status end of 2023:** 2.2 This report is in progress and will be delivered in time. There have been Partnership projects concluded within the timeframe, but analysis of the economic benefit of EMPIR projects is progressing as planned. 2.3 Collaborators can only be appointed after the project started, a first indication will come at their first periodic reporting which is at M18. For Call 2021 this is foreseen in Spring 2024. 2.4 This is not possible to give evidence now, as the interviews to gain those numbers will start a year after the conclusion of the projects. 2.5 see point 2.3, This KPI had been achieved so far.
3. To contribute to the creation and diffusion of high-quality new knowledge, competences and skills across the Union in the context of lifelong learning and with a view to achieving societal transformation, including through enhancing capability	By mid of 2024 3.1 At least 18 seminars, and stakeholders events should have been organised by the EMNs. Every year from 2026 onwards: 3.2 The average number of peer reviewed scientific publications per project that	**Status end of 2023:** 3.1 16 EMN related events had been held within 2022, and 16 events within 2023. Altogether 32 events have been arranged by the end of 2023. (see https://www.euramet.org/publications-media-centre/events/archived-events) 3.2 No Partnership projects have been completed yet. However, up until the end of 2023, 28 peer-reviewed scientific publications have been reported from Call 2021 projects in their

[81] Collaborators are those organisations that have signed a Letter of Agreement (or equivalent) with the consortium.

for innovation;	completed in the previous year should be at least 6. 3.3 On average at least 4 seminars and courses are arranged towards stakeholder communities per concluded project. By the end of 2030: 3.4 The Field-Weighted Citation82 Index of peer reviewed publications produced by the Metrology Partnership is at least 1. 3.5 Funding distributed to non NMIs and DIs will have been 35 % of the total funding distributed in the areas supporting the EMNs. 3.6 At least 10 patent applications are produced for every 100 concluded projects.	first 18 months. For more details see section 6.3. 3.3 A first indication will come at their first periodic reporting which is at M18. For Call 2021 this is foreseen in Spring 2024. Seminars in general are coming when the first results have been achieved and can be taught to others. 3.4 Not applicable yet. 3.5 Not applicable yet. 3.6 Not applicable yet.

Partnership	Number of projects	Number of industry and adopters per TP	Average number per project	EMPIR	Number of projects	Number of industry and adopters per TP	Average number per project	KPI on target?
DIT	2	23	11,5	n/a	0	0		N/A
GRD	10	113	11,3	ENV+ENG	37	307	8,3	Y
FUN	8	51	6,4	FUN	18	106	5,9	Y
HLT	7	65	9,3	HLT	19	129	6,8	Y
IEM	7	53	7,6	n/a				N/A
IND	14	153	10,9	IND	41	309	7,5	Y
NRM	18	102	5,7	NRM	37	166	4,5	Y
RPT	7	34	4,9	RPT	21	39	1,9	Y

4. To contribute fully and effectively, by 2030, to the design and implementation of specific standards and regulations that underpin public policies addressing societal, economic and environmental	Every year: 4.1 At least 10 % of activity in the selected joint research projects is dedicated to normative research & to support regulation. Every year from 2026 onwards:	**Status end of 2023:** 4.1

[82] Field-weighted Citation Impact (FWCI) is an author-level metric introduced and applied by Scopus SciVal. FWCI equals to the total citations actually received divided by the total citations that would be expected based on the average of the considered field. FWCI of 1 means that the output performs just as expected for the global average. More than 1 means that the author outperforms the average, and less than 1 means that the author underperforms.

challenges

4.2 The number of contributions to standard committees that underpin policy or regulation that underpin public policies addressing societal, economic, and environmental challenges should be at least 400.

Overall:

4.3 At least 40 % of activity in the selected joint research projects is dedicated to the twin transition.

Call year	Funded Value	Standardisation participation	Percentage of Standardisation /participation
2021	€ 25 946 402	€ 10 262 134	39,6%
2022	€ 41 751 652	€ 11 430 540	27,4%
2023	€ 52 145 132	€ 10 912 098	20,9%
2024	€ 0	€ 0	0,0%
2025	€ 0	€ 0	0,0%
2026	€ 0	€ 0	0,0%
2027	€ 0	€ 0	0,0%
TOTAL	€ 119 843 186	€ 32 604 772	27,2%

4.2 A first indication will come at their first periodic reporting which is at M18. For Call 2021 this is foreseen in Spring 2024.

4.3

Call year	Funded Value	Twin participation	Percentage of Twin /participation
2021	€ 25 946 402	€ 24 124 181	93,0%
2022	€ 41 751 652	€ 11 063 312	26,5%
2023	€ 52 145 132	€ 2 299 430	4,4%
2024	€ 0	€ 0	0,0%
2025	€ 0	€ 0	0,0%
2026	€ 0	€ 0	0,0%
2027	€ 0	€ 0	0,0%
TOTAL	€ 119 843 186	€ 37 486 922	31,3%

5. To unleash the potential of metrology among end-users, including SMEs and industrial stakeholders, as an instrument which contributes to the achievement of the Union goals for the digital and green transitions.

By the end of 2022 onwards:

5.1 The share of selected research topics where end-users including industrial stakeholders and early adopters of the proposed technologies, have contributed to the objectives should be at least 10 %.

By the end of 2026 onwards:

5.2 At least 0.75 % of projects can demonstrate an end-user engagement mechanism after the project.

5.3 On average 1.5 outreach events are arranged towards stakeholder communities per concluded project. Uptake of co-created scientific results and innovative solutions.

5.4 To provide examples that the joint research projects are addressing the identified Union policy priorities and global challenges (including SDGs)

Status end of 2023:

5.1

Year	Total No. SRTs published	No. SRTs with Early adopters	% Early Adopters (KPI 5.1)
2021	30	26	87 %
2022	55	50	91 %
2023	57	44	77 %
Totals	142	120	85 %

5.2 The first projects of the Call 2021 will finish in 2025, exact results will be obtained from that time onwards on.

5.3 A first indication will come at their first periodic reporting which is at M18. For Call 2021 this is foreseen in Spring 2024.

5.4 A first indication will come at their first periodic reporting which is at M18. For Call 2021 this is foreseen in Spring 2024.

Annex 4 – EMN liaisons with other partnerships and initiatives as stated in the EURAMET EMNs Report of July 2024[6]

Partnership	EMN or TC	Type of cooperation
Risk Assessment of Chemicals (Cluster 1)	EMN Pollution Monitoring, TC-MC	Informal liaison
Water4all (Cluster 1)	EMN Pollution Monitoring	Informal liaison
Key Digital Technologies (Cluster 4)	Advanced Manufacturing, Smart North	Invitee to EURAMETs open consultation
Smart Networks and Services (Cluster 4)	Smart North	Informal liaison
High Performance Computing (Cluster 4)	Quantum Technologies (through the Quantum Flagship)	Informal liaison
Photonics (Cluster 4)	Quantum Technologies, Smart North	Informal liaison
Made in Europe (Cluster 4)	Advanced Manufacturing	Stakeholder council
Clean Hydrogen (Cluster 5)	Energy Gases, Smart Grids, Potential EMN Clean Energy	Stakeholder council & MoU with EURAMET
Clean Energy Transition (Cluster 5)	EMN Clean Energy, Energy Gases, Smart Grids, Smart North	Informal liaison
Build4People (Cluster 5)	Radiation Protection	Informal liaison
EOSC	Mathmet and EURAMET	Informal liaison
Sustainable Blue Economy Partnership	Pollution Monitoring, Safe and Sustainable Food and Climate and Ocean Observation	Informal liaison, but participating in Blue Economy's SRIA workshop

Existing EMN contacts with European funding infrastructures beyond the Partnerships under Horizon Europe

European initiative	EMN	Type of cooperation
GERG (European Gas Research Group)	Energy Gases	MoU
Framework Partnership Agreements for open testing and experimentation and for pilot production capabilities for quantum technologies (FPA)	Quantum Technologies	Participation in the FPA consortium
Quantum Flagship	Quantum Technologies	Participation in the SRA developing group
Quantum Flagship	Quantum Technologies	Member of the Quantum Coordination Board (Core Group, and thematic group on Metrology and Sensing)
IOC Ocean Best Practices Programme	Climate and Ocean Observation (Ocean Section)	Informal liaison
MINKE (Metrology for Integrated Marine Management and Knowledge-	Climate and Ocean Observation (Ocean Section)	Liaison through project deliverables of Minke

European initiative	EMN	Type of cooperation
Transfer Network)		
PIANOFORTE (EURATOM Work programme)	Radiation Protection	Invitee to GM and co-creation of work programme
ICRP (International Commission on Radiological Protection)	Radiation Protection	MoU
IAEA	Radiation Protection	Invitation to GM