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PART 1/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT
Accompanying the document

**Proposal for a
DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
on the participation of the Union in the European Partnership on Metrology jointly
undertaken by several Member States**

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Glossary

<i>Term or acronym</i>	<i>Meaning or definition</i>
AI	Artificial Intelligence
BIPM	International Bureau of Weights and Measures
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CIPM	International Committee for Weights and Measures
DI	Designated Institute
EIT-KICs	Knowledge & Innovation Communities of the European Institute Innovation & Technology
EMN	European Metrology Network
EMPIR	European Metrology Programme for Innovation and Research
EMRP	European Metrology Research Programme
ERA	European Research Area
EURAMET	European Association for National Metrology Institutes
FP	Framework Programme
FP7	Seventh Framework Programme
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IoT	Internet of Things
ISO	International Organization for Standardization
JRP	Joint Research Project
MFF	Multiannual Financial Framework

MoU	Memorandum of Understanding
NIM	Chinese National Institute of Metrology
NIST	National Institute of Standards and Technology, United States
NMI	National Metrology Institute
PPP	Public-Private Partnership
cPPP	Contractual Public-Private Partnership
PTB	Physikalisch Technische Bundesanstalt, Germany
R&D	Research & Development
R&I	Research & Innovation
SDGs	Sustainable Development Goals
SI Units	International System of Units
SMEs	Small and Medium size Enterprises
SRIA	Strategic Research and Innovation Agenda
TFEU	Treaty on the Functioning of the European Union
UNIDO	United Nations Industrial Development Organization

PART 1 - COMMON FOR ALL CANDIDATE INSTITUTIONALISED EUROPEAN PARTNERSHIPS

1. BACKGROUND AND CONTEXT TO EUROPEAN PARTNERSHIPS IN HORIZON EUROPE AND FOCUS OF THE IMPACT ASSESSMENT– WHAT IS DECIDED

1.1. Focus and objectives of the impact assessment

This impact assessment accompanies the Commission proposal for Institutionalised European Partnerships to be funded under Horizon Europe, the 2021-2027 Framework Programme for EU Research and Innovation (R&I)¹. It sets out to **help decide in a coordinated manner the right form of implementation for specific candidate initiatives** based on a common approach and methodology to individual assessments². It also provides an **horizontal perspective on the portfolio of candidate European Partnerships** to identify further efficiency and coherence gains for more impact.

European Partnerships are initiatives where the Union, together with private and/or public partners (such as industry, public bodies or foundations) commit to support jointly the development and implementation of an integrated programme of R&I activities. The rationale for establishing such initiatives is to achieve the objectives of Horizon Europe more effectively than what can be attained by other activities of the programme³.

Based on the Horizon Europe Regulation, European Partnerships may be set up using **three different forms**: “Co-funded”, “Co-programmed” and “Institutionalised”. The setting-up of **Institutionalised Partnerships** involves new EU legislation and the establishment of dedicated implementing structures based on Article 185 or 187 of the Treaty on the Functioning of the EU (TFEU). This requires an impact assessment to be performed.

The Horizon Europe Regulation defines **eight priority areas**, scoping the domains in which Institutionalised Partnerships could be proposed⁴. Across these priority areas, **13 initiatives** have been identified as **suitable candidate initiatives** for Institutionalised Partnerships because of their objectives and scope. This impact assessment aims to identify whether 12 of these initiatives⁵ need to be implemented through this form of implementation and would not deliver equally well with traditional calls of Horizon Europe or other lighter forms of European Partnerships under Horizon Europe. This means assessing whether each of these initiatives meets the necessity test set in the **selection criteria** for European Partnerships in the Horizon Europe Regulation, Annex III.

¹ Horizon Europe Regulation (common understanding), <https://data.consilium.europa.eu/doc/document/ST-7942-2019-INIT/en/pdf>

² Based on the European Commission Better Regulation framework (SWD (2017) 350) and supported by an external study coordinated by Technopolis Group (to be published in 2020).

³ For further details on these points, see below Section 1.2.2.

⁴ Set out in the Annex Va of the Horizon Europe Regulation (common understanding), <https://data.consilium.europa.eu/doc/document/ST-7942-2019-INIT/en/pdf>

⁵ Only 12 are subject to this impact assessment, as one initiative on High Performance Computing has already been subject to an impact assessment in 2017 (SEC(2018) 47).

This assessment is done **without any budgetary consideration**, as the overall budget of the Multiannual Financial Framework of the EU – and hence of Horizon Europe – for the next financing period is not known at this stage⁶.

1.2. The political and legal context

1.2.1. Shift in EU priorities and Horizon Europe framework

European priorities have evolved in the last decades, and reflect the social, economic, and environmental challenges for the EU in the face of global developments. In her Political Guidelines for the new European Commission 2019 – 2024⁷, the new Commission President put forward six overarching priorities, which reach well beyond 2024 in scope⁸. Together with the Sustainable Development Goals (SDGs), these priorities will shape future EU policy responses to the challenges Europe faces, and thus also give direction to EU research and innovation.

As part of the Multi-annual Financial Framework (MFF) 2021-27 the new EU Framework Programme for Research and Innovation **Horizon Europe will play a pivotal role for Europe to lead the social, economic, and environmental transitions needed to achieve these European policy priorities**. It will be more impact driven with a strong focus on delivering European added value, but also be more effective and efficient in its implementation⁹. Horizon Europe finds its rationale in the daunting challenges that the EU is facing, which call for “*a radical new approach to developing and deploying new technologies and innovative solutions for citizens and the planet on a scale and at a speed never achieved before, and to adapting our policy and economic framework to turn global threats into new opportunities for our society and economy, citizens and businesses.*” While Horizon Europe continues the efforts of strengthening the scientific and technological bases of the Union and foster competitiveness, a more strategic and impact-based approach to EU R&I investment is taken. Consequently, the **objectives of Horizon Europe** highlight the need *to deliver on the Union strategic priorities and contribute to the realisation of EU objectives and policies, contribute to tackling global challenges, including the Sustainable Development Goals by following the principles of the Agenda 2030 and the Paris Agreement*¹⁰.

In this context, **at least 35 % of the expenditure from actions under the Horizon Europe Programme will have to contribute to climate action**. Furthermore, a **Strategic Plan** is co-designed with stakeholders to identify **key strategic orientations for R&I support** for 2021-2024 in line with the EU priorities. In the Orientations towards the first Strategic Plan for Horizon Europe, the need to strategically prioritise and “*direct a substantial part of the funds towards the areas where we believe they will*

⁶ EU budget commitments to the European Partnership candidates can only be discussed and decided following the political agreement on the overall Multiannual Financial Framework and Horizon Europe budgetary envelopes. The level of EU contribution for individual partnerships should be determined once there are agreed objectives, and clear commitments from partners. Importantly, there is a ceiling to the partnership budgets in Pillar II of Horizon Europe (the legal proposal specifies that *the majority of the budget in pillar II shall be allocated to actions outside of European Partnerships*).

⁷ https://ec.europa.eu/info/strategy/priorities-2019-2024_en

⁸ 1.A European Green Deal; An economy that works for people; A Europe fit for the Digital Age; Promoting our European way of life; A Stronger Europe in the World; and 6.A New push for European Democracy

⁹ EC (2018) *A Modern Budget for a Union that Protects, Empowers and Defends. The Multiannual Financial Framework for 2021-2027*. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2018) 321 final

¹⁰ Article 3, Common understanding regarding the proposal for Horizon Europe Framework Programme.

matter the most” is emphasised. The Orientations specify, that actions under Pillar II of Horizon Europe “Global Challenges and European Industrial Competitiveness” will target only selected themes of especially high impact that significantly contribute to delivering on the political priorities of the Union. Most of the candidate European Partnerships fall under this Pillar.

1.2.2. Key evolutions in the approach to partnerships in Horizon Europe

Since their start in 1984 the successive set of Framework Programmes uses a variety of instruments and approaches to support R&I activities, address global challenges and industrial competitiveness. Collaborative, competition-based and excellence-driven R&I projects funded through Work Programmes are the most traditional and long-standing approach for implementation. Since 2002, available tools also include **partnerships**, whereby the Union together with private and/or public partners commit to jointly support the development and implementation of a R&I programme. These were introduced as part of creating the European Research Area (ERA) to align national strategies and overcome fragmentation of research effort towards an increased scientific, managerial and financial integration of European research and innovation. Interoperable and integrated national research systems would allow for better flows of knowledge, technology and people. Since then, the core activities of the partnerships consist of building critical mass mainly through collaborative projects, jointly developing visions, and setting strategic agendas.

As analysed in the **interim evaluation of Horizon 2020**¹¹, a considerable repertoire of partnership initiatives have been introduced over time, with 8 forms of implementation¹² and close to 120 partnership initiatives running under Horizon 2020 - without clear exit strategies and concerns about their degree of coherence, openness and transparency. Even if it is recognised that these initiatives allow setting long-term agendas, structuring R&I cooperation between otherwise dispersed actors, and leveraging additional investments, the evaluation points to the complexity generated by the proliferation of instruments and initiatives, and their insufficient contribution to policies at EU and national level.

Box 1 Key lessons from the interim evaluation of Horizon 2020 and R&I partnerships

- The **Horizon 2020 Interim Evaluation** concludes that the overall partnership landscape has become overly complex and fragmented. It identifies the need for rationalisation, improve their openness and transparency, and link them with future EU R&I missions and strategic priorities.
- The **Article 185 evaluation** finds that these public-public partnerships have scientific quality, global visibility and networking/structuring effects, but should in the future focus more on the achievement of policy impacts. From a systemic point of view, it found that the EU public-to-public cooperation (P2P) landscape has become crowded, with insufficient coherence.
- The **Article 187 evaluation** points out that Public-Private Partnership (PPP) activities need to be brought more in line with EU, national and regional policies, and calls for a revision of the Key Performance Indicators. As regards the **contractual PPPs (cPPPs)** their reviews identified challenges of coherence among cPPPs and the need to develop collaborations and synergies with other relevant initiatives and programmes at EU, national and regional level.

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Over 80% of respondents to the Open Public Consultation (OPC) indicated that a significant contribution by future European Partnerships is ‘fully needed’ to achieve climate-related goals, to develop and effectively deploy technology, and for EU global competitiveness in specific sectors/domains. Views converged across all categories of respondents, including citizens, industry and academia.

(EIT-KICs), ERA-NETs, European Joint Programmes, Joint Programming Initiatives.

The impact assessment of Horizon Europe identifies therefore the need to **rationalise the EU R&I funding landscape**, in particular with respect to partnerships, as well as to **re-orient partnerships towards more impact** and delivery on EU priorities. To address these concerns and to realise the higher ambition for European investments, Horizon Europe puts forward **a major simplification and reform for the Commission’s policy on R&I partnerships**¹³. Reflecting its pronounced systemic nature aimed at contributing to EU-wide ‘transformations’ towards the sustainability objectives, Horizon Europe indeed intends to make a more effective use of these partnerships with a **more strategic, coherent and impact-driven approach**. Key related changes that apply to all forms of European Partnerships encapsulated in Horizon Regulation are summarised in the Box

Box 2 Key features of the revised policy approach to R&I partnerships under Horizon Europe based on its impact assessment

- ✓ **Simpler architecture & toolbox** by streamlining 8 partnership instruments into 3 implementation forms (Co-Funded, Co-Programmed, Institutionalised), under the umbrella ‘European Partnerships’
- ✓ **More systematic and transparent approach** to selecting, implementing, monitoring, evaluating and phasing out all forms of partnerships (**criteria** for European Partnerships):
 - The selection of Partnerships is embedded in the strategic planning of Horizon Europe, thereby ensuring coherence with the EU priorities. The selection criteria require that partnerships are established with stronger ex-ante commitment and higher ambition.
 - The implementation criteria stipulate that initiatives adopt a systemic approach in achieving impacts, including broad engagement of stakeholders in agenda-setting and synergies with other relevant initiatives to promote the take-up of R&I results.
 - A harmonised monitoring & evaluation system will be implemented, and ensures that progress is analysed in the wider context of achieving Horizon Europe objectives and EU priorities.
 - All partnerships need to develop an exit strategy from Framework Programme funding. This new approach is underpinned by principles of openness, coherence and EU added value.
- ✓ **Reinforced impact orientation:**
 - Partnerships are established only if there is evidence they support achieving EU policy objectives more effectively than other Horizon Europe actions, by demonstrating a clear vision and targets (**directionality**) and corresponding long-term commitments from partners (**additionality**).
 - European Partnerships are expected to provide mechanisms – based on a concrete roadmap - to join up R&I efforts between a broad range of actors towards the development and uptake of innovative solutions in line with EU priorities, serving the economy and society, as well as scientific progress.
 - They are expected to develop close synergies with national and regional initiatives, acting as dynamic change agents, strengthening linkages within their respective ecosystems and along the value chains, as well as pooling resources and efforts towards the common EU objectives.

below.

Under Horizon Europe, a ‘European Partnership’¹⁴ is defined as *“an initiative where the Union, prepared with early involvement of Member States and/or Associated Countries, together with private and/or public partners (such as industry, universities, research organisations, bodies with a public service mission at local, regional, national or international level or civil society organisations including foundations and NGOs), commit to jointly support the development and implementation of a programme of research and innovation activities, including those related to market, regulatory or policy uptake”*.

The Regulation further specifies that European Partnerships shall adhere to the *“principles of Union added value, transparency, openness, impact within and for Europe, strong leverage effect on sufficient scale, long-term commitments of all the involved parties, flexibility in implementation, coherence, coordination and*

¹³ Impact assessment of Horizon Europe, Commission Staff Working Document, SWD(2018)307.

¹⁴ Article 8 and Annex III of the Horizon Europe Regulation (common understanding)

complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions”.

1.3. Why should the EU act

1.3.1. Legal basis

Proposals for Institutionalised European Partnerships are based on:

- 1) Article 185 TFEU which allows the Union to make provision, in agreement with the Member States concerned, for participation in research and development programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes; or
- 2) Article 187 TFEU according to which the Union may set up joint undertakings or any other structure necessary for the efficient execution of Union research, technological development and demonstration programmes¹⁵.

1.3.2. Subsidiarity

The EU should act only in areas where there is demonstrable advantage that the action at EU level is more effective than action taken at national, regional or local level. Research is a shared competence between the EU and its Member States according to the TFEU. Article 4 (3) specifies that in the areas of research, technological development and space, the EU can carry out specific activities, including defining and implementing programmes, without prejudice to the Member States’ freedom to act in the same areas. The candidate initiatives focus on areas where there is a demonstrable value added in acting at the EU level due to the scale, speed and scope of the efforts needed for the EU to meet its long-term Treaty objectives and deliver on its strategic policy priorities and commitments. In addition, the proposed initiatives should be seen as complementary and reinforcing national and sub-national activities in the same area. Overall European Partnerships find their **rationale in addressing a set of systemic failures**¹⁶:

- Their primary function is to create a platform for a strengthened **collaboration** and knowledge exchange between various actors in the European R&I system and an enhanced **coordination** of strategic research agendas and/or R&I funding programmes. They aim to address **transformational failures** to better align agendas and policies of public and private funders, pool available resources, create critical mass, avoid unnecessary duplication of efforts, and leverage sufficiently large investments where needed but hardly achievable by single countries.
- The concentration of efforts and pooling of knowledge on common priorities to solve multi-faceted societal and economic challenges is at the core of these initiatives. Specifically, enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems are among the key objectives of these instruments. In the light of Horizon Europe, the aim is to **drive system transitions and transformations towards EU priorities**.
- Especially in fast-growing technologies and sectors such as ICT, there is a need to **react to emerging opportunities** and address systemic failures such as shortage in skills or critical mass or cross-sectoral cooperation along the value chains that

¹⁵ Both Articles are under Title XIX of the TFEU - Research and Technological Development and Space.

¹⁶ The Interim Evaluation of Horizon 2020 and the impact assessment of Horizon Europe provide qualitative and quantitative evidence on these points. Sections 1 and 2 of each impact assessment on candidate European Partnerships include more detail on the necessity to act at EU level in specific thematic areas.

would hamper attainment of future European leadership and/or open strategic autonomy.

- They also aim to address **market failures** predominantly to enhancing industry investments thanks to the sharing of risks.

2. THE CANDIDATE EUROPEAN PARTNERSHIPS – WHAT NEEDS TO BE DECIDED

2.1. Portfolio of candidates for Institutionalised European Partnerships

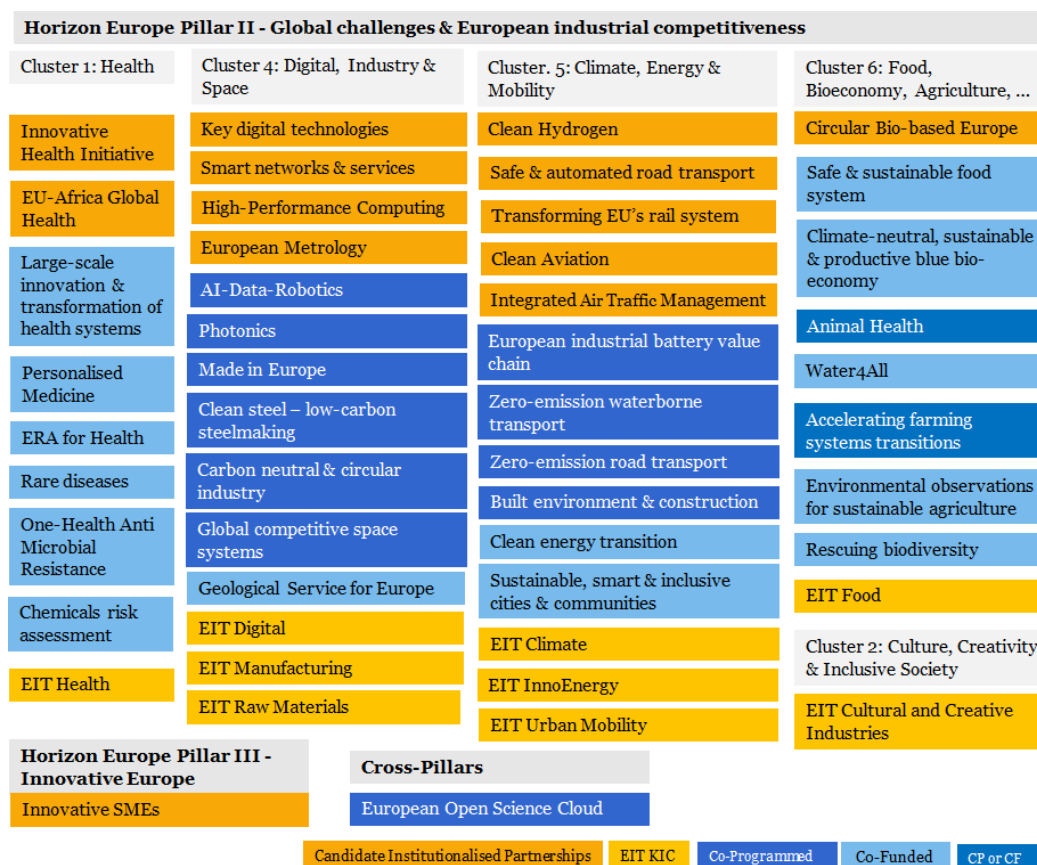
The new approach for more objective-driven and impactful European Partnerships is reflected in the way candidate Partnerships have been identified. It involved a co-design exercise aiming to better align these initiatives with societal needs and policy priorities, while broadening the range of actors involved. Taking into account the 8 areas for Institutionalised European Partnerships set out in the Horizon Europe Regulation¹⁷, a co-design exercise as part of the Strategic Planning process of Horizon Europe lead to the identification of **49 candidates for Co-funded, Co-programmed or Institutionalised European Partnerships**¹⁸. Out of these, **13 were identified as suitable candidate Institutionalised Partnerships because of their objectives and scope**¹⁹. Whilst the Co-Funded and Co-Programmed Partnerships are linked to the comitology procedure (including the adoption of the Strategic Plan and the Horizon Europe Work Programmes), Institutionalised Partnerships require the adoption of legislation and are subject to an impact assessment. The Figure below gives an overview of all candidate European Partnerships according to their primary relevance to Commission priorities for 2019-2024.

¹⁷ Horizon Europe Regulation (common understanding), Annex Va.

¹⁸ Shadow configuration of Strategic Programme Committee for Horizon Europe. The list of candidate European Partnerships is described in “Orientations towards the Strategic Plan of Horizon Europe” - Annex 7

¹⁹ Only 12 are subject to this impact assessment, as one initiative on High Performance Computing has already been subject to an impact assessment in 2017 (SEC(2018) 47)

Figure 1 - Overview of the candidates for Co-Funded, Co-Programmed and Institutionalised European Partnerships according to Horizon Europe structure



Source: Technopolis group (2020)

There are only three partnerships for which implementation as an Institutionalised Partnership under Article 185 is an option, i.e. European Metrology, the EU-Africa Global Health partnership, and Innovative SMEs. Ten partnerships are candidates for Institutionalised Partnerships under Article 187. Overall the initiatives can be categorised into ‘horizontal’ partnerships and ‘vertical’ partnerships.

The ‘horizontal’ partnerships have a central position in the overall portfolio, as they are expected to develop methodologies and technologies for application in the other priority areas, ultimately supporting European open strategic autonomy in these areas as well as technological sovereignty. These ‘horizontal’ partnerships are typically proposed as Institutionalised or Co-programmed Partnerships, in addition to a number of EIT KICs, they cover mainly the digital field in addition to space, creative industries and manufacturing, but also the initiative related to Innovative SMEs. ‘Vertical’ partnerships are focused on the needs and development of specific application areas, and are primarily expected to support enhanced environmental sustainability thereby addressing Green Deal related objectives. They also deliver on policies for more people centred economy, through improved wellbeing of EU citizen and the economy, like health related candidate European Partnerships.

2.2. Assessing the necessity of a European Partnership and possible options for implementation

Horizon Europe Regulation Article 8 stipulates that Institutionalised European Partnerships based on Article 185 and 187 TFEU shall be implemented only where other parts of the Horizon Europe programme, including other forms of European

Partnerships would not achieve the objectives or would not generate the necessary expected impacts, and if justified by a long-term perspective and high degree of integration. At the core of this impact assessment is therefore the need to demonstrate that the impacts generated through a Partnership approach go beyond what could be achieved with traditional calls under the Framework Programme – the Baseline Option. Secondly, it needs to assess if using the Institutionalised form of a Partnership is justified for addressing the priority.

For all candidate Institutionalised European Partnerships the options considered in this impact assessment are the same, i.e.:

- Option 0 – Baseline option – Traditional calls under the Framework Programme
- Option 1 – Co-programmed European Partnership
- Option 2 – Co-funded European Partnership
- Option 3 – Institutionalised Partnership
 - Sub-option 3a Institutionalised Partnerships based on Art 185 TFEU
 - Sub-option 3b Institutionalised Partnerships based on Art 187 TFEU

2.2.1. Option 0 - Baseline option – Traditional calls

Under this option, strategic programming for R&I in the priority area will be done through the mainstream channels of Horizon Europe. The related priorities will be implemented through **traditional calls** of Horizon Europe covering a range of actions, mainly R&I and/or innovation actions but also coordination and support actions, prizes or procurement. Most actions involve consortia of public and/or private actors in ad hoc combinations, while some actions are single actor (mono-beneficiary). There will be no dedicated implementation structure and no support other than what is foreseen in the related Horizon Europe Work Programme. This means that discontinuation costs/benefits of predecessor initiatives should be factored in for capturing the baseline situation when relevant.

Under this option, strategic planning mechanisms in the Framework Programme will allow for a high level of flexibility in the ability of traditional calls to respond to particular needs over time, building upon additional input in co-creation from stakeholders and programme committees involving Member States. The Union contribution to addressing the priority covers the full duration of the initiative, during the lifetime of Horizon Europe. Without a formal EU partnership mechanism, it is less likely that the stakeholders will develop a joint Strategic Research Agenda and commit to its implementation or agree on mutual commitments and contributions outside their participation in funded projects.

2.2.2. European Partnerships

Under this set of options, three different forms of implementation are assessed: Co-funded, Co-Programmed, Institutionalised European Partnerships. These have **commonalities that cannot serve as a distinguishing factor in the impact assessment process**. They are all based on agreed objectives and expected impacts and underpinned by Strategic Research and Innovation Agendas / roadmaps that are shared and committed to by all partners in the partnership. They all have to follow the same set of criteria along their lifecycle, as defined in the Horizon Europe Regulation (Annex III), including ex ante commitment from partners to mobilise and contribute resources and investments. The Union contribution is defined for the full duration of the initiative for all European Partnerships. The Horizon Europe legal act introduces few additional requirements for

Institutionalised Partnerships, e.g. the need for long-term perspective, strong integration of R&I agendas, and financial contributions.

Figure 2 - Key differences in preparation and implementation of European Partnerships

Type	Legal form	Implementation
Co-Programmed	Contractual arrangement / MoU	Division of labour , whereby Union contribution is implemented through Framework programme and partners' contributions under their responsibility.
Co-Funded	Grant Agreement	Union provides co-funding for an integrated programme with distributed implementation by entities managing and/or funding national research and innovation programmes
Institutionalised based on Article 185/187 TFEU	Basic act (Council regulation, Decision by European Parliament and Council)	Integrated programme with centralised implementation

The main differences between the different forms of European Partnerships are in their preparation and in the way they function, as well as in the overall impact they can trigger. The Co-Programmed form is assessed as the simplest, and the Institutionalised the most complex to prepare and implement. The functionalities of the different form of Partnerships – compared to the baseline option – are presented in Figure 3. They relate to the types of actors Partnerships can involve and their degree of openness, the types of activities they can perform and their degree of flexibility, the degree of commitment of partners and the priority setting system, and their ability to work with their external environment (coherence), etc. These key distinguishing factors will be at the basis of the comparison of each option to determine their overall capacity to deliver what is needed at a minimised cost.

Figure 3 Overview of the functionalities provided by each form of European Partnerships, compared to the traditional calls of Horizon Europe (baseline)

Baseline: Horizon Europe calls	Option 1: Co-Programmed	Option 2: Co-Funded	Option 3a: Institutionalised Art 185	Option 3b: Institutionalised Art 187
Type and composition of actors (including openness and roles)				
<u>Partners:</u> N.A., no common set of actors that engage in planning and implementation <u>Priority setting:</u> open to all, part of Horizon Europe Strategic planning <u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules	<u>Partners:</u> Suitable for all types: private and/or public partners, foundations <u>Priority setting:</u> Driven by partners, open stakeholder consultation, MS in comitology <u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules	<u>Partners:</u> core of national funding bodies or govern-mental research organisations <u>Priority setting:</u> Driven by partners, open stakeholder consultation <u>Participation in R&I activities:</u> limited, according to national rules of partner countries	<u>Partners:</u> National funding bodies or governmental research organisation <u>Priority setting:</u> Driven by partners, open stakeholder consultation <u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules, but possible derogations	<u>Partners:</u> Suitable for all types: private and/or public partners, foundations <u>Priority setting:</u> Driven by partners, open stakeholder consultation <u>Participation in R&I activities:</u> fully open in line with Horizon Europe rules, but possible derogations
Type and range of activities (including additionality and level of integration)				
<u>Activities:</u> Horizon Europe standards that allow broad range of individual actions <u>Additionality:</u> no additional activities and	<u>Activities:</u> Horizon Europe standard actions that allow broad range of individual actions, support to market, regulatory or policy/	<u>Activities:</u> Broad, according to rules/programmes of participating States, State-aid rules, support to regulatory or policy/	<u>Activities:</u> Horizon Europe standards that allow broad range of individual actions, support to regulatory or policy/societal uptake, possibility to	<u>Activities:</u> Horizon Europe standards that allow broad range of individual actions, support to regulatory or policy/societal uptake, possibility to systemic

Baseline: Horizon Europe calls	Option 1: Co-Programmed	Option 2: Co-Funded	Option 3a: Institutionalised Art 185	Option 3b: Institutionalised Art 187
investments outside the funded projects <u>Limitations:</u> No systemic approach beyond individual actions	societal uptake <u>Additionality:</u> Activities/investments of partners, National funding <u>Limitations:</u> Limited systemic approach beyond individual actions	societal uptake <u>Additionality:</u> National funding <u>Limitations:</u> Scale & scope depend on participating programmes, often smaller in scale	systemic approach <u>Additionality:</u> National funding	approach (portfolios of projects, scaling up of results, synergies with other funds). <u>Additionality:</u> Activities/investments of partners/ national funding
Priority-setting process and directionality				
<u>Priority setting:</u> Strategic Plan and annual work programmes, covering max. 4 years. <u>Limitations:</u> Fully taking into account existing or to be developed SRIA/ roadmap	<u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution Input to FP annual work programme drafted by partners, finalised by EC (comitology) Objectives & commitments set in contractual arrangement	<u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution Annual work programme drafted by partners, approved by EC Objectives & commitments set in Grant Agreement	<u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution Annual work programme drafted by partners, approved by EC Objectives & commitments set in legal act	<u>Priority setting:</u> Strategic R&I agenda/ roadmap agreed between partners & EC, covering usually 7 years, incl. allocation of Union contribution Annual work programme drafted by partners, approved by EC (veto-right in governance) Objectives & commitments set in legal act
Coherence: internal (Horizon Europe) & external (other Union programmes, national programmes, industrial strategies)				
<u>Internal:</u> Coherence between different parts of the FP Annual Work programme can be ensured by EC <u>External:</u> Limited for other Union programmes, no synergies with national/regional programmes & activities	<u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC <u>External:</u> Limited synergies with other Union programmes & industrial strategies. If MS participate, with national/ regional programmes & activities	<u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC <u>External:</u> Synergies with national/ regional programmes & activities	<u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC <u>External:</u> Synergies with national/ regional programmes & activities	<u>Internal:</u> Coherence among partnerships & with parts of the FP Annual Work programme can be ensured by partners & EC <u>External:</u> Synergies with other Union programmes and industrial strategies If MS participate, with national/ regional programmes & activities

2.2.2.1. Option 1 - Co-programmed European Partnership

This form of European Partnership is **based upon a Memorandum of Understanding or a Contractual Arrangement** signed by the Commission and the private and/or public partners. Private partners are represented by industry associations, which also support the daily management of the partnership. This type of partnership would allow for a large degree of flexibility for the activities, partners and priorities to continuously evolve. The commitments of partners are political efforts described in the contractual arrangement and the contributions from partners are provided in kind more than financially. The priorities for the calls, proposed by the Partnership's members for integration in the Horizon Europe's Work Programmes, are subject to further input from Member States (comitology) and Commission services. The Union contribution is implemented within the executive agency managing Horizon Europe calls for research and innovation projects proposals. The full array of Horizon Europe instruments can be used, ranging from research and innovation (RIA) types of actions to coordination and support actions (CSA) and including grants, prizes, and procurement.

2.2.2.2. Option 2 – Co-funded European Partnership

The Co-funded European Partnership is **based on a Grant Agreement** between the Commission and a consortium of partners, resulting from a specific call in the Horizon Europe Work Programme. This form of implementation only allows to address public partners at its core. Typically these provide co-funding to a common programme of activities established and/or implemented by entities managing and/or funding national R&I programmes. The recipients of the EU co-funding implement the initiative under their responsibility, with national funding/resources pooled to implement the programme with co-funding from the Union. The expectation is that these entities would cover most if not all EU Member States. Calls and evaluations would be organised centrally, beneficiaries in selected projects would be funded at national level, following national funding rules.

2.2.2.3. Option 3 – Institutionalised European Partnership

This type of Partnership is the most complex and high-effort arrangement, and requires meeting additional requirements. Institutionalised European Partnerships are **based on a Council Regulation (Article 187 TFEU or a Decision by the European Parliament and Council (Article 185 TFEU))** and are implemented by dedicated structures created for that purpose. These regulatory needs limit the flexibility for a change in the core objectives, partners, and/or commitments as these would require amending legislation. The basic rationale for this type of partnership is the need for a strong integration of R&I agendas in the private and/or public sectors in the EU in order to address a strategic challenge. It is therefore necessary to demonstrate that other forms of implementation would not achieve the objectives or would not generate the necessary expected impacts, and that a long-term perspective and high degree of integration is needed. For both Article 187 and 185 initiatives, contributions from partners can be in the form of financial and in-kind contributions. Eligibility for participation and funding follows by default the rules of Horizon Europe, unless a derogation is introduced in the basic act.

Option 3a - Institutionalised Partnerships based on Article 185 TFEU

Article 185 of the TFEU allows the Union to participate in programmes jointly undertaken by Member States and limits therefore the scope to **public partners** which are Member States and Associated Third Countries. This type of Institutionalised Partnership aims therefore at reaching the greatest possible impact through the integration of national and EU funding, aligning national strategies in order to optimise the use of public resources and overcome fragmentation of the public research effort. It brings together R&I governance bodies of most if not all EU Member States (legal requirement: at least 40% of Member States) as well as Associated Third Countries that designate a legal entity (Dedicated Implementation Structure) of their choice for the implementation. By default, participation of non-associated Third Countries is not foreseen. Such participation is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement.

Option 3b - Institutionalised Partnerships based on Article 187 TFEU

Article 187 of the TFEU allows the Union to set up joint undertakings or any other structure necessary for the efficient execution of EU research, technological development and demonstration programmes. This type of Institutionalised Partnership brings together a stable set of **public and private partners** with a strong commitment to taking a more

integrated approach and requires the set-up of a dedicated legal entity (Union body, Joint Undertaking (JU)) that carries full responsibility for the management of the Partnership and implementation of the calls. Different configurations are possible:

- Partnerships focused on creating strategic industrial partnerships where, most often, the partner organisations are represented by one or more industry associations, or in some cases individual private partners;
- Partnerships coordinating national ministries, public funding agencies, and governmental research organisations in the Member States and Associated Countries;
- Or a combination of the two: the so-called tripartite model.

Participation of non-associated Third Countries is only possible if foreseen in the basic act and subject to conclusion of an international agreement.

2.3. Overview of the methodology adopted for the impact assessment

The methodology for each impact assessment is based on the Commission Better Regulation Guidelines²⁰ to evaluate and compare options with regards to their **efficiency, effectiveness and coherence**. This also integrates **key selection criteria for European Partnerships**.

Box 3 Summary of European Partnerships selection criteria²¹

- **Effectiveness** in achieving the related objectives and impacts of the Programme;
- **Coherence** and synergies of the European Partnership within the EU R&I landscape;
- **Transparency & openness** as regards the identification of priorities and objectives and the involvement of partners & stakeholders from the entire value chain, backgrounds & disciplines;
- Ex-ante demonstration of **additionality** and **directionality**;
- Ex-ante demonstration of the partners' **long term commitment**.

2.3.1. Overview of the methodologies employed

In terms of **methods and evidence used**, the impact assessments draw on an external study covering all candidate Institutionalised European Partnerships in parallel to ensure a high level of coherence and comparability of analysis, in addition to an horizontal analysis.²² For all initiatives, the understanding of the overall context of the candidate institutionalised European Partnerships relied on desk research, including among others the lessons learned from previous partnerships. This was complemented by the analysis of a range of quantitative and qualitative evidence, including evaluations of past and ongoing initiatives; foresight studies; statistical analyses of Framework Programmes application and participation data, and Community Innovation Survey data; analyses of science, technology and innovation indicators; reviews of academic literature; sectoral competitiveness studies and expert hearings. The analyses included a portfolio analysis, a stakeholder and social network analysis in order to profile the actors involved as well as their co-operation patterns, and an assessment of the partnerships' outputs (bibliometrics and patent analysis). A cost modelling exercise was performed in order to feed into the efficiency assessments of the partnership options, as described below. Public

²⁰ European Commission (2017), Better Regulation Guidelines (SWD (2017) 350)

²¹ For a comprehensive overview of the selection criteria for European Partnerships, see Annex 6.

²² Technopolis Group (2020), Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe, Final Report, Study for the European Commission, DG Research & Innovation

consultations (both open and targeted) supported the comparative assessment of the policy options. For each initiative, up to 50 relevant stakeholders were interviewed by the external contractor (policymakers, business including SMEs and business associations, research institutes and universities, and civil organisations, among others). In addition, the analysis was informed by the results of the Open Public Consultation run between September and November 2019, the consultation of Member States through the Strategic Programme Committee and the online feedback received on the Inception Impact Assessments of the set of initiatives.

A more detailed description of the methodology and evidence base that were mobilised, completed by thematic specific methodologies, is provided in Annexes 4 and 6.

2.3.2. *Method for identifying the preferred option*

The first step of the assessments consisted in scoping the problems that the initiatives are expected to solve given the overall economic, technological, scientific and social context, including the lessons to be learned from past and ongoing partnerships on what worked well and less well. This supported the identification of the objectives of the initiative in the medium and long term with the underlying intervention logic – showing how to get there.

Given the focus of the impact assessment on comparing different forms of implementation, the Better Regulation framework has then been adapted to introduce “**key functionalities needed**” - making the transition between the definition of the objectives and what would be crucial to achieve them *in terms of implementation*. The identification of “key functionalities needed” for each initiative as an additional step in the impact assessment is based on the distinguishing factors between the different options (see Section 2.2.1). In practical terms, each option is assessed on the basis of the degree to which it would allow for the key needed functionalities to be covered, as regards e.g. the type and composition of actors that can be involved (‘openness’), the range of activities that can be performed (including additionality and level of integration), the level of directionality and integration of R&I strategies; the possibilities offered for coherence and synergies with other components of Horizon Europe, including other Partnerships (internal coherence), and the coherence with the wider policy environments, including with the relevant regulatory and standardisation framework (external coherence). This approach guides the identification of discarded options while allowing at the same time a structured comparison of the options not only as regards their effectiveness, efficiency and coherence, but also against a set of other key selection criteria for European Partnerships (openness, transparency, directionality)²³.

In line with the Better Regulation Framework, the assessment of the effectiveness, efficiency and coherence of each option is made compared to the baseline. Therefore, for each of these aspects the performance of using traditional calls under Horizon Europe is first estimated and scored 0 to serve as a reference point. This includes the discontinuation costs/benefits of existing implementation structures when relevant. The policy options are then scored compared to the baseline with a + and – system with a two-point scale, to show a slightly or highly additional/lower performance compared to the baseline. A scoring of 0 of a policy option means that it would deliver as much as the baseline option.

²³ The criterion on the ex-ante demonstration of partners’ long term commitment depends on a series of factors that are unknown at this stage, and thus fall outside the scope of the analysis.

On the basis of the evidence collected, the intervention logic of each initiative and the key functionalities needed, the impact assessments first evaluate the **effectiveness** of the various policy options to deliver on their objectives. To be in line with the Horizon Europe impact framework, the fulfilment of the specific objectives of the initiative is translated into ‘expected impacts’ - how success would look like -, differentiating between scientific, economic/ technological, and societal (including environmental) impacts. Each impact assessment considers to which extent the different policy options provides the ‘key functionalities needed’ to achieve the intended objectives. The effectiveness assessment does not use a compound score but shows how the options would deliver on the different types of expected impacts. This is done to increase transparency and accuracy in the assessment of options²⁴.

A similar approach is followed to evaluate the coherence of options with the overarching objectives of the EU’s R&I policy, and distinguishes between **internal** and **external coherence**. Specifically, internal coherence covers the consistency of the activities that could be implemented with the rest of Horizon Europe, including European Partnerships (any type). External coherence refers to the potential for synergies and/or complementarities (including risks of overlaps/gaps) of the initiative with its external environment, including with other programmes under the MFF 2021-27, but also the framework conditions at European, national or regional level (incl. regulatory aspects, standardisation).

To compare the expected costs and benefits of each option (**efficiency**), the thematic impact assessments broadly follow a cost-effectiveness approach²⁵ to establish to which extent the intended objectives can be achieved for a given cost. A preliminary step in this process is to obtain a measure of the expected costs of the policy options, to be used in the thematic assessments. As the options correspond to different implementation modes, relevant cost categories generally include the costs of setting-up and running an initiative. For instance, set-up costs includes items such as the preparation of a European Partnership proposal and the preparation of an implementation structure. The running costs include the annual work programme preparation costs. Where a Partnership already exists, discontinuation costs and cost-savings are also taken into account²⁶. The table below provides an overview of the cost categories used in the impact assessment and a qualitative scoring of their intensity when compared to the baseline option (traditional calls). Providing a monetised value for these average static costs would have been misleading, because of the different features and needs of each candidate initiative.²⁷ The table shows the overall administrative, operational and coordination costs of the various options. These costs are then put into context in the impact assessments to reflect the expected co-financing rates and the total budget available for each of the policy options, assuming a common Union contribution (cost-efficiency):

²⁴ In the thematic impact assessments, scores are justified in a detailed manner to avoid arbitrariness and spurious accuracy. A qualitative or even quantitative explanation is provided of why certain scores were given to specific impacts, and why one option scores better or worse than others.

²⁵ For further details, see Better Regulation Toolbox # 57.

²⁶ Discontinuation costs will bear winding down and social discontinuation costs and vary depending on e.g. the number of full-time-equivalent (FTEs) staff concerned, the type of contract (staff category and duration) and applicable rules on termination (e.g. contracts under Belgian law or other). If buildings are being rented, the cost of rental termination also apply. As rental contracts are normally tied to the expected duration of the current initiatives, these termination costs are likely to be very limited. In parallel, there would also be financial cost-savings related to the closing of the structure, related to operations, staff and coordination costs in particular. This is developed further in the individual efficiency assessments.

²⁷ A complete presentation of the methodology developed to assess costs as well as the sources used is described in the external study supporting this impact assessment (Technopolis Group, 2020).

- The costs related to the baseline scenario (traditional calls under Horizon Europe) are pre-dominantly the costs of implementing the respective Union contribution via calls and project, managed by the executive agencies (around 4%, efficiency of 96% for the overall investment).
- For a Co-Programmed partnership the costs of preparation and implementation increase only marginally compared to the baseline (<1%), but lead to an additional R&I investment of at least the same amount than the Union contribution²⁸ (efficiency of 98% for the overall investment).
- For a Co-Funded partnership the additional R&I investment by Member States accounts for 2,3 times the Union contribution²⁹. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the national programmes, can be estimated at 6% of the Union contribution (efficiency of 98% related to the overall investment).
- For an Article 185 initiative the additional R&I investment by Member States is equal to the Union contribution³⁰. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the dedicated implementation structure, can be estimated at 7% of the Union contribution (efficiency of 96% related to the overall investment).
- For an Article 187 initiative the additional R&I investment by partners is equal to the Union contribution³¹. The additional costs compared to the baseline of preparing and implementing the partnership, including the management of the Union contribution implemented by the dedicated implementation structure, can be estimated at 9% of the Union contribution (efficiency of 94% related to the overall investment).

Figure 4 - Intensity of additional costs compared with Horizon Europe Calls (for Partners, stakeholders, public and EU)

Cost items	Baseline: traditional calls	Option 1: Co-programmed	Option 2 Co-funded	Option 3a -Art. 185	Option 3b -Art. 187
Preparation and set-up costs					
Preparation of a partnership proposal (partners and EC)	0		↑↑		
Set-up of a dedicated implementation structure		0		Existing: ↑ New: ↑↑	Existing: ↑↑ New: ↑↑↑
Preparation of the SRIA / roadmap	0		↑↑		
Ex-ante Impact Assessment for partnership		0		↑↑↑	
Preparation of EC proposal and negotiation		0		↑↑↑	
Running costs (Annual cycle of implementation)					
Annual Work Programme preparation	0		↑		
Call and project implementation	0	0 In case of MS contributions: ↑	↑	↑	↑

²⁸ Minimum contributions from partners equal to the Union contribution.

²⁹ Based on the default funding rate for programme co-fund actions of 30%, partners contribute with 70% of the total investment.

³⁰ Based on the minimum requirement in the legal basis that partners contribute at least 50% of the budget.

³¹ Based on the minimum requirement in the legal basis that partners contribute at least 50% of the budget.

Cost items	Baseline: traditional calls	Option 1: Co-programmed	Option 2 Co-funded	Option 3a -Art. 185	Option 3b -Art. 187
Cost to applicants	Comparable, unless there are strong arguments of major differences in oversubscription				
Partners costs not covered by the above	0	↑	0	↑	↑
Additional EC costs (e.g. supervision)	0	↑	↑	↑	↑↑
Winding down costs					
EC	0				↑↑↑
Partners	0	↑	0	↑	↑

Notes: 0: no additional costs, as compared with the baseline; ↑: minor additional costs, as compared with the baseline; ↑↑: medium additional costs, as compared with the baseline; ↑↑↑: higher costs, as compared with the baseline.

The cost categories estimated for the common model are then used to develop a scorecard analysis and further refine the assessment of options for each of the 12 candidate Institutionalised Partnerships. Specifically, the scores related to the set-up and implementation costs are used in the thematic impact assessments to consider the scale of the expected benefits and thereby allow a simple “value for money” analysis (**cost-effectiveness**)³². In carrying out the scoring of options, the results of fieldwork, desk research and stakeholder consultation undertaken and taken into account.

For the **identification of the preferred option**, the scorecard analysis builds a hierarchy of the options by individual criterion and overall in order to identify a single preferred policy option or in case of an inconclusive comparison of options, a number of ‘retained’ options or hybrid. This exercise supports the systematic appraisal of alternative options across multiple types of monetary, non-monetary and qualitative dimensions. It also allows for easy visualisation of the pros and cons of each option. Each option is attributed a score of the adjudged performance against each criterion with the three broad appraisal dimensions of effectiveness, efficiency and coherence.

As a last step, the alignment of the preferred option with key criteria for the selection of European Partnerships is described, reflecting the outcomes of the ‘**necessity test**’.³³ The monitoring and evaluation arrangements are concluding the assessment, with an identification of the key indicators to track progress towards the objectives over time.

2.4. Horizontal perspective on candidate Institutionalised European Partnerships

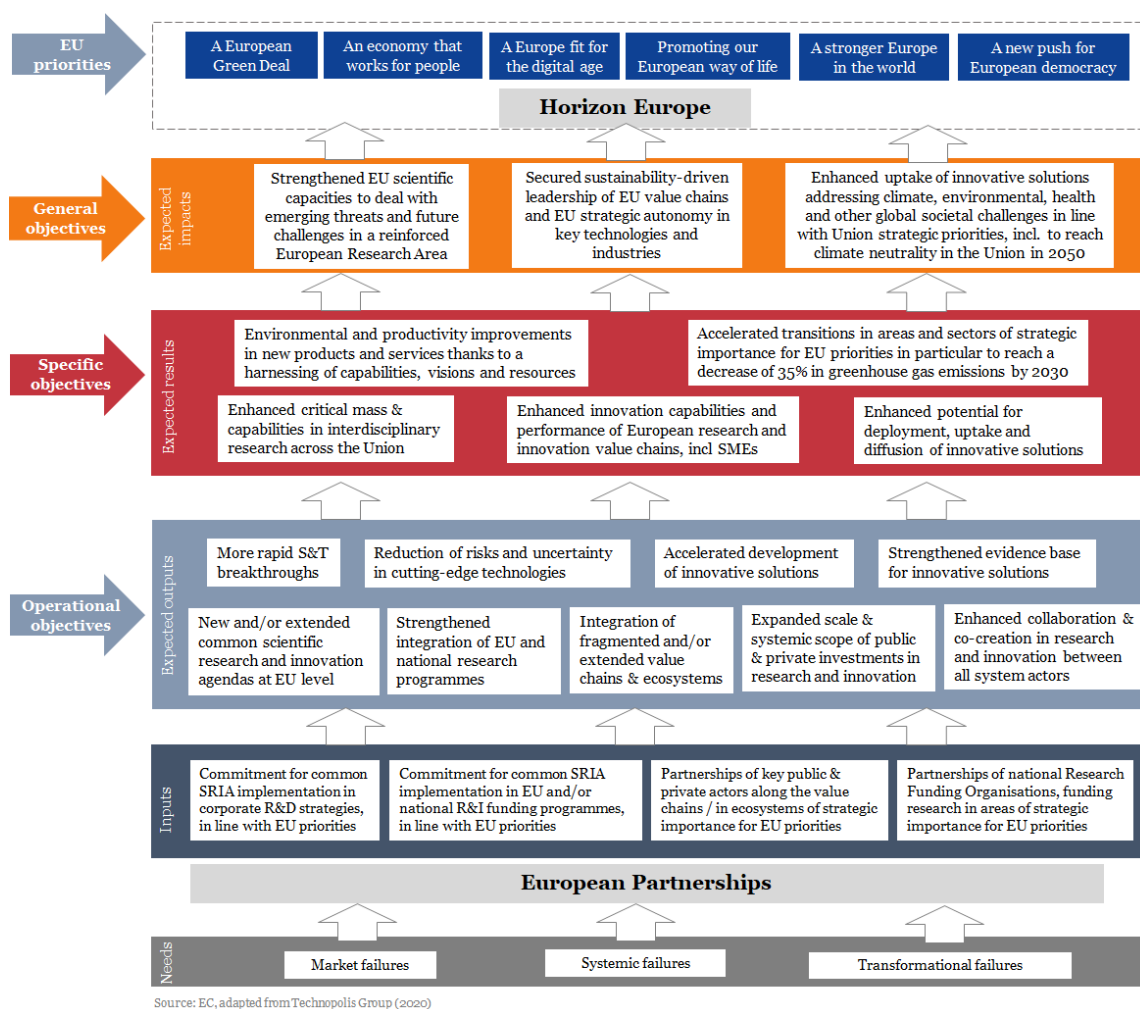
2.4.1. Overall impact orientation, coherence and efficiency needs

The consolidated **intervention logic** for the set of candidate Institutionalised European Partnerships in the Figure below builds upon the objectives as reported in the individual impact assessments.

³² More details on the methodology can be found in Annex 4.

³³ Certain aspects of the selection criteria will be further addressed/ developed at later stages, notably in the context of preparing basic acts (e.g. Openness and Transparency; Coherence and Synergies), in the Strategic Research and Innovation Agendas (e.g. Directionality and Additionality), and by collecting formal commitments (Ex-ante demonstration of partners’ long-term commitment).

Figure 5 – Overall intervention logic of the European Partnerships under Horizon Europe



When analysed as a package the 12 candidate Institutionalised European Partnerships are expected to support the achievement of the European policy priorities targeted by Horizon Europe by pursuing the following joint general objectives:

- Strengthening EU scientific capacities to deal with emerging threats and future challenges in a reinforced European Research Area;
- Securing sustainability-driven leadership of EU value chains and EU open strategic autonomy in key technologies and industries; and
- Enhancing the uptake of innovative solutions addressing climate, environmental, health and other global societal challenges in line with Union strategic priorities, including to reach climate neutrality in the Union in 2050.

In terms of specific objectives, they jointly aim to:

- Enhance the critical mass and scientific capabilities in interdisciplinary research and innovation across the Union;
- Accelerate the transitions in areas and sectors of strategic importance for EU priorities, in particular to reach a decrease of 35% in greenhouse gas emissions by 2030, and deliver on the digital transition;
- Enhance the innovation capabilities and performance of European research and innovation value chains, including SMEs;
- Enhance the potential for deployment, uptake and diffusion of innovative solutions;

- e) Deliver environmental and productivity improvements in new products and services thanks to a harnessing of EU capabilities and resources.

In terms of their operations, taking an horizontal perspective on all initiatives allows for the identification of further possible collective efficiency and coherence gains for more impact:

- **Coherence for impact:** The extent and speed by which the expected results and impacts will be reached, will depend on the scale of the R&I efforts triggered, the profile of the partners involved, the strength of their commitments, and the scope of the R&I activities funded. To be fully effective it comes out clearly that future partnerships need to operate over their whole life cycle in full coherence with their environment, including potential end users, regulators and standardisation bodies. This relates also to the alignment with relevant EU, national or regional policies and synergies with R&I programmes. This needs to be factored in as of the design stage to ensure a wide take-up and/or deployment of the solutions developed, including their interoperability.
- **Collaboration for impact:** Effectiveness could also be improved collectively through enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems. An adequate governance structure appears in particular necessary to ensure cross-fertilisation between all European Partnerships. This applies not only to initiatives where similar R&I topics are covered and/or the same stakeholders involved or targeted, but also to the interconnections needed between the ‘thematic’ and the ‘vertical’ Partnerships, as these are expected to develop methodologies and technologies for application in EU priority areas. Already at very early stages of preparing new initiatives, Strategic Research and Innovation Agendas and roadmaps need to be aligned, particularly for partnerships that develop enabling technologies that are needed in other Partnerships. The goal should be to achieve greater impacts jointly in light of common challenges.
- **Efficiency for impact:** Potential efficiency gains could also be achieved by joining up the operational functions of Joint Undertakings that do not have a strong context dependency and providing them through a common back-office³⁴. A number of operational activities of the Joint Undertakings are of a technical or administrative nature (e.g. financial management of contracts), or procured from external service providers (e.g. IT, communication activities, recruitment services, auditing) by each Joint Undertaking separately. If better streamlined this could create a win-win situation for all partners leading to better harmonization, economies of scales, and less complexity in supervision and support by the Commission services.

2.4.2. *Analysis of coherence of the overall portfolio of candidate initiatives at the thematic level*

Looking at the coherence of the set of initiatives at the thematic level, the “**digital centric**” initiatives have a strong focus on supporting the digital competitiveness of the EU ecosystem. Their activities are expected to improve alignment and coordination with Member States and industry for the development of world-competitive EU strategic digital technology value chains and associated expertise. Addressing the Key Digital

³⁴ See Annex 6 for an overview of key functions/roles that could be provided by a common back office.

Technologies, the 5G and 6G connectivity needs as part of a Smart Networks and Services initiative and the underlying supercomputing capacities through a European High Performance Computing initiative present potential for synergies that can be addressed through cooperative actions (e.g. joint calls, coordinated support activities, etc.). They may as well profit from and contribute to Partnerships envisaged for Photonics, AI, data, robotics, Global competitive space system and Made in Europe, together with the EIT Digital. Synergies between these initiatives and several programmes (Digital Europe and Connecting Europe as well as cohesion programmes) are needed in areas where EU industry has to develop leadership and competitiveness in the global digital economy. They are expected to impact critical value chains including on sectors where digital is a strong enabler of transformation (health, industrial manufacturing, mobility/transport, etc.).

The **transport** sector have to respond to systemic changes linked to decarbonisation and digitalisation. Large scale R&I actions are needed to prepare the transition of these complex sectors to provide clean, safer, digital and economically viable services for citizens and businesses. Past decades have shown that developing and implementing change is difficult in transport due to its systemic nature, many stakeholders involved, long planning cycles and large investments needed. A systemic modernisation of the air traffic management infrastructure through an Integrated Air Traffic Management initiative should ensure safety and sustainability of air transport, while a Clean Aviation initiative should focus on the competitiveness of tomorrow's clean aircrafts made in Europe. The initiative for Transforming Europe's rail system would comprehensively address the rail sector to make it a cornerstone in tomorrow's clean and efficient door-to-door transport services, affordable for every citizen as well as the most climate-friendly mode of transport for freight. Connected and Automated Mobility is the future of road transport, but Europe is threatened to fall behind other global regions with strong players and large harmonised markets. The initiative Safe and Automated Road Transport would bring stakeholders together, creating joint momentum in digitalising road transport and developing new user-based services. Stronger links and joint actions will be established between initiatives to enable common progress wherever possible. The Clean Hydrogen initiative would be fundamental to that regard. Synergies would also be sought with partnerships driving the digital technological developments.

To deliver a deep decarbonisation of highly emitting industrial sectors such as the steel, transport and chemical industries would require the production, distribution and storage of **hydrogen** at scale. The candidate hydrogen initiative would have a central positioning in terms of providing solutions to the challenges for sustainable mobility and energy, but also is expected to operate in synergies with other industry related initiatives. The initiative would interact in particular with initiatives on the zero emission road and water transport, transforming Europe's railway system, clean aviation, batteries, circular industry, clean steel and built environment partnerships. There are many opportunities for collaboration for the delivery and end-use of hydrogen. However, the Clean Hydrogen initiative would be the only partnership focused on addressing hydrogen production technologies.

Metrology, the science of measurement, is an enabler across all domains of R&I. It supports the monitoring of the Emissions Trading System, smart grids and pollution, but also contributes to meeting demands for measurement techniques from emerging digital technologies and applications. More generally, emerging technologies across a wide range of fields from biotechnologies, new materials, health diagnostics or low carbon technologies are giving rise to demands requiring a world-leading EU metrology system.

The initiative for a **Circular Bio-based Europe** is intended to solve a shortage of industry investments in the development of bio-based products whose markets do not have yet certain long-term prospects. The **Innovative Health Initiative** and **EU-Africa Global Health** address the lack of investments in the development of solutions to specific health challenges. The initiative on **Innovative SMEs** supports innovation-driven SMEs in participating in international, collaborative R&I projects with other innovative firms and research-intensive partners. As a horizontal initiative it is expected to help innovative SMEs to grow and to be successfully embedded in global value chains by developing methodologies and technologies for potential application in the other partnership areas or further development by the instruments of the European Innovation Council.

The description of the interconnections between all initiatives for each Horizon Europe cluster is provided in the policy context of each impact assessment and further assessed in the coherence assessment for each option.

PART 2 - THE CANDIDATE EUROPEAN PARTNERSHIP ON METROLOGY

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

Metrology is the scientific study of measurement. It establishes a **common definition of units** (weight, time, distance, scale, etc.). This matters as a public good for lots of important areas, such as defence and security but even more safety of products, health, energy, climate change, and environment.

When citizens purchase, use or benefit from new products and services, metrology offers an important safeguard for fair and accurate trade, optimisation of production, and implementation of regulations and standards affecting the above public goods. It is also a key ingredient to support new emerging technologies (e.g. quantum). As such, it is a **key enabler** of economic and societal activity and a public good³⁵.

Research in metrology can be divided into three (overlapping) activities. The first is the **definition of units** of measurement. The second is the **application** of these units in measurement in practice. The third is **traceability**, which links measurements made in practice back to the defined standard of measurement. The national metrology institutes (NMIs) and their designated institutes (DIs) ensure that these activities are coherent and compliant with scientifically and internationally recognised methods and definitions. A detailed description of the functioning of the NMIs is set out in Annex 6, section 2.2.

European research and innovation initiatives in metrology focus on two activities:

- scientific or fundamental metrology, which concerns **generating new knowledge** (e.g. through the establishment of common definition of units of measurement); and
- applied or technical metrology, which deals with the application of measurement to industrial and wider societal processes via a “**metrology value chain**” ranging from researchers, standard setters, industries to end-user – be it a consumer, be it a regulator.

There are also links to legal metrology, which covers the regulation of and statutory requirements for calibrating measuring instruments,

Quality of research in metrology and the bodies conducting research with the necessary capabilities have wide-ranging **impacts on the economy and society**, including industry, climate, energy, environment and health. It is also **key to innovation** in many fields by enabling the demonstration and validation of new concepts and technologies. In addition, it is critical in ensuring **global recognition of standards** in measurement.

Due to its significance for national security, metrology competence in Europe remains at Member States’ level.

This document focuses on assessing the most effective, efficient and coherent way of implementing a research initiative on metrology under Horizon Europe.

³⁵ As discussed by Swann, metrology exhibits two principal characteristics of a public good: non-rivalry and non-excludability (Swann GMP, ‘John Barber’s Pioneering Work on the Economics of Measurement Standards’, Workshop in Honour of John Barber, University of Manchester, 2 December 2005).

1.1 Emerging challenges in the field

The study “100 Radical Innovation Breakthroughs for the future” from 2019 lays out several groups of technologies with a direct need for metrology research and development, such as robotics, computing, biomedicine, and new advanced materials³⁶. Overall, emerging technologies in digital (big data, Artificial Intelligence (AI), robotics, industry 4.0), additive manufacturing (3D printing), quantum technologies, biotechnologies, new materials and low carbon technologies are expected to contribute to future innovation.

Emerging technologies place new and challenging demands on the metrology system, such as more accurate measurements and entirely new forms and methods in metrology to support the innovation process. An example of such a field is the new demands of applications within Internet of Things (IoT). Another example concerns quantum technologies; the overall quantum computing market is expected to grow from EUR 86 million in 2019 to EUR 262 million in 2024³⁷.

The application of metrology also ensures accurate measurements in health diagnostics and delivery. Many medical innovations must be demonstrated to be effective and safe before they can be adopted by healthcare systems³⁸. The recent pandemics due to the COVID-19 virus will for instance require laboratory testing for which metrology will be crucial to ensure public trust into future tests. Medical equipment is another important priority for research in metrology at international level³⁹.

The BOHEMIA foresight study⁴⁰ sets out a number of positive scenarios for Europe. The study highlights the role of “Cheap, Renewable Energy” and points to the importance of energy efficiency measures and the development of renewables-friendly regulatory frameworks. Efficient energy efficient measures will need to be supported by metrology, which can also contribute to ensuring regulatory frameworks are fit for purpose.

Stakeholders opinions

Almost all **stakeholders interviewed** across the value-chain reported that metrology underpins research and innovation in almost all sectors of the economy and most technology domains as well as key policy fields in climate, environment and health and safety⁴¹. These same stakeholders also reported on the need for the continual development of metrology capabilities to provide accurate measurement data in new technologies and fields and to ensure capabilities in existing metrology domain remain relevant to continually evolving needs.

Stakeholders that were interviewed identified a range of challenges across many sectors that require the development of new methods of measurement, and the validation and certification of new technologies. Challenges identified by the stakeholders interviewed included, for example,

³⁶ 100 Radical Innovation Breakthroughs for the future (2019), European Commission, doi: 10.2777/563770

³⁷ Markets and Markets Research Report No. SE 5490, May 2019

³⁸

[https://www.euramet.org/index.php?eID=tx_securedownloads&p=1175&u=0&g=0&t=1611343676&hash=979e2203883c38ac0bd5a7ac30ed7d19bd57557b&file=Media/docs/EMNs/TraceLabMed/2019-04-](https://www.euramet.org/index.php?eID=tx_securedownloads&p=1175&u=0&g=0&t=1611343676&hash=979e2203883c38ac0bd5a7ac30ed7d19bd57557b&file=Media/docs/EMNs/TraceLabMed/2019-04-03_TraceLabMed_Summary_v4.pdf)

[03_TraceLabMed_Summary_v4.pdf](https://www.euramet.org/index.php?eID=tx_securedownloads&p=1175&u=0&g=0&t=1611343676&hash=979e2203883c38ac0bd5a7ac30ed7d19bd57557b&file=Media/docs/EMNs/TraceLabMed/2019-04-03_TraceLabMed_Summary_v4.pdf)

³⁹ <https://www.bipm.org/en/worldwide-metrology/covid-19-metrology.html>

⁴⁰ Transitions on the Horizon – Perspectives for the European Union’s future research and innovation policies – Study, <https://op.europa.eu/en/publication-detail/-/publication/21d456ff-6eb5-11e8-9483-01aa75ed71a1/language-en/format-PDF/source-91686077>, 2018.

⁴¹ Interviews conducted during 2019.

references to metrology to ensure accurate measurement of chemical and biological materials and processes, soft-matter, digital technologies, quantum and new materials.

Stakeholders interviewed from across different stakeholder groups also identified challenges associated with the uptake of new technologies innovation (e.g. quantum technologies or 5G) and integration of innovation within existing complex systems (e.g. integration of renewables into the energy system) via a require coordinated standardisation to ensure pan-European uptake.

1.2 EU relative positioning in the field

The challenges ahead are numerous but Europe is well positioned to tackle them. Dedicated support under the Sixth and Seventh Framework Programmes, as well as Horizon 2020, has enabled Europe to establish a position as a world leader in metrology research. When support was discontinued under the Fifth Framework Programme, it led in the past to a loss of capacity for new forms of measurement, loss of momentum in metrology research for emerging technologies and, consequently, a hindering of competitiveness.

The present situation as a world leader can first be illustrated by the number of publications, average of relative impact factors (ARIF), citations (ARC) and highly-cited papers (HCP) as shown in Table 1.

Table 1: Scientific impact of EURAMET and internationally comparable National Metrology Institutes (2008-2015)

National Metrology Institutes	Total no. of papers	Scientific impact		
		ARIF	HCP _{10%}	ARC
Total – EURAMET NMIs	9,579	1.06	10%	1.08
NIST – National Institute of Standards and Technology (USA)	13,563	1.36	17%	1.62
KRISS – Korea Research Institute of Metrology	2,912	1.15	9%	0.89
NIM - Chinese National Institute of Metrology	2,052	0.48	3%	0.38
NIMJ – National Metrology Institute of Japan	1,422	0.87	8%	0.80

Source: Technopolis report, forthcoming, 2020

Second, more than half of the international metrology committees are being chaired/vice-chaired by persons from European institutes⁴².

Third, Europe outweighs other regions in the world when it comes to available calibration and measurement capabilities offered by European institutes: 11335 approved capabilities (covering physical infrastructure and skilled metrologists) exist in Europe compared to 6453 in the Asia-Pacific region and 4631 in the Inter-American metrology region⁴³.

⁴² Referring to CIPM committee chairs/vice-chairs and reported in: Expert Group report, Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR), https://ec.europa.eu/research/evaluations/pdf/emrp-empir_expgrp_report_final.pdf (2017).

⁴³ <https://www.bipm.org/kcdb/cmc/statistics/public>, statistics at 4 June 2020.

However, Europe’s leading position in metrology is increasingly facing major challenges from other global regions in terms of scale and focus of investment as well as long-term financial commitment to metrology objectives.

In the US, the National Institute of Standards and Technology (NIST), the national metrology institute, had an overall annual budget of USD 724.5 million in 2018 and 2019⁴⁴. Noteworthy actions include a dedicated programme for exploratory measurement sciences (“lab programme”) with an annual budget in excess of USD 60 million and a research programme for fundamental measurements, including quantum science that has an annual budget of more than USD 160 million. Notably, while some scale back of the overall NIST mandate has occurred in 2020, the metrology-related programmes are maintained at the same level of funding as previous years, highlighting the strategic investment of the US in fundamental research and emerging technologies for metrology.

According to the latest information available⁴⁵, the National Institute of Metrology (NIM) in China had an operational budget of EUR 180 million in 2018. In addition, China implemented a targeted research programme for metrology between 2016-2019 of about EUR 65 million and funded 160 collaborative research projects across China.

An overview of how metrology is supported through the European Framework Programme for research and innovation is provided in the box below, allowing to identify how best to move forward in practice given the challenges ahead and EU positioning in the field.

Box 4 – Support for the field in the previous Framework Programmes – key strengths & weaknesses identified

What was/is being done with EU research and innovation funding until now

Dedicated R&I activities related to metrology including collaborative projects have been particularly supported through the EMRP and EMPIR initiatives under the Seventh Framework Programme and Horizon 2020⁴⁶. Both initiatives were evaluated by external experts in October 2017.

The first partnership in metrology (the European Metrology Research Programme – EMRP) was established under Article 185 TFEU (formerly Article 169) in 2009, with a budget of EUR 400 million and focussing on delivering a joint European Research Area for metrology. This involved funding of joint research projects and researchers’ mobility. The partnership combined the efforts of 19 Member States and four associated countries.

Building on the lessons from EMRP and on an ex-ante impact assessment in 2013, the European Metrology Programme for Innovation and Research – EMPIR – was launched in 2014 under Horizon 2020. With the aim of focussing more on major societal challenges, it broadened the scope and ambition of the metrology partnership to address innovation in addition to research. Participation widened compared to EMRP, with 23 Member States and five associated countries engaging. EMPIR allowed building a significant capacity as regards physical infrastructure and skilled metrologists, whereby the more advanced metrology institutes transferred knowledge and shared expertise, thus

⁴⁴ <https://www.nist.gov/director/congressional-and-legislative-affairs/nist-appropriations-summary-fy-2018-fy-2020>

⁴⁵ Information received by NIM.

⁴⁶ There was also one call launched as a proof of concept for collaborative metrology research projects under the ERA-NET+ instrument in 2007, called iMERA+.

allowing less advanced institutes to participate as partners in projects. However, the interim evaluation concluded there is still a significant capacity gap between metrology institutes today.

Details on the way the partnership functions are available in Annex 6.

What has or is being achieved so far

In October 2017, the Commission published the final evaluation of the EMRP programme and an interim evaluation of the EMPIR programme⁴⁷.

EMRP brought together any relevant players for metrology research from all participating countries: national metrology institutes (NMI), their designated institutes (DI) and linked laboratories. These players were all capable to participate in EMRP funded projects.

In addition, the EMRP confirmed that, by marshalling resources, the programme was enhancing the inter-disciplinarity of metrology research, which had traditionally been organised around specific disciplines, such as length, time, and mass. Thus, EMRP allowed for research projects directly contributing to meeting societal challenges in relation to, for example, health⁴⁸, environment⁴⁹ and energy⁵⁰.

EMRP enabled European metrology institutes, industrial organisations and academia to collaborate on joint research projects within specified fields: industry, energy, environment, health, new technologies and SI units. Annual EMRP research calls between 2009 and 2013 enabled the funding of 119 projects⁵¹.

These 119 projects were led by 957 transnational research infrastructures. They involved participation by 916 organisations in addition to national metrology institutes, of which 50% were from universities and research and technology organisations and 41% were from industry. There are also 140 non-European participants in these projects⁵².

The final evaluation of EMRP in 2017 confirmed the success of having built capacities for undertaking metrology research in each of the participating countries. As a consequence, the evaluations concluded that there is no longer a need to fund the mobility of researchers between participating countries in the future under a future European partnership but this could be left to national budgets.

A second finding of the final evaluation of EMRP was to highlight the need for including quality infrastructures but also independent academia, universities and industries to address emerging trends for metrology research much more effectively.

⁴⁷ Expert Group report, Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR), https://ec.europa.eu/research/evaluations/pdf/emrp-empir_expgrp_report_final.pdf (2017).

⁴⁸ Investing more than EUR 74 million in health-related metrology, with almost 200 publications and EUR 210 million of projected increase in turnover (<https://www.euramet.org/metrology-for-societys-challenges/metrology-for-health/>).

⁴⁹ An excess of 270 publications within the field of environment with EUR 77 million of investment (<https://www.euramet.org/metrology-for-societys-challenges/metrology-for-environment/>).

⁵⁰ With an investment of EUR 78 million, 367 publications, and training courses for more than 13000 people with the thematics of energy metrology (<https://www.euramet.org/metrology-for-societys-challenges/metrology-for-energy/>).

⁵¹ Expert Group report, Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR), https://ec.europa.eu/research/evaluations/pdf/emrp-empir_expgrp_report_final.pdf (2017).

⁵² Ibid.

Compared to EMRP, a new process was accordingly put in place under the EMPIR to engage more universities and industry from outside the national institutes: a 30% target was set for EU funding to beneficiaries outside the core national metrology institute partners. A target of EUR 400 million was also set for increased turnover stemming from applications and products developed by industries in the EMPIR funded collaborative projects.

As a conclusion, the EMRP and EMPIR partnerships have enabled Europe to establish a leading global position in measurement, traceability and standard setting. In terms of scientific publications in metrology, during the years 2010-2018, five out of the top ten most prolific organisations were European.

What are the key areas for improvement & unmet challenges?

The evaluation of 2017 recommended a new partnership at European level based on three recommendations:

First, the **strategic component** should be strengthened. The national metrology institutes should engage with other stakeholder communities to develop “metrology value chains” that could support the Single Market. The evaluation did not advocate a centralised European structure to implement the recommendation. It favoured a bottom-up approach to metrology activities based on agreed European-level objectives. For these reasons, the evaluation recommended that pan-European “centres of excellence” in the form of networks (“European Metrology Networks”- EMN) should feature in a potential successor partnership in order to deepen the capacity of metrology to respond to major societal challenges.

Secondly, the **role of external stakeholders**, such as universities and industry should no longer be limited to participation in projects selected after calls. Instead, they should in future be more involved in programme development as well as have more opportunities to participate in projects compared to the 30% participation rate foreseen for external participants under EMPIR.

The third recommendation was for **programme implementation** to proactively address metrology applications in emerging scientific areas and focus more on tackling societal challenges.

1.3 EU policy context beyond 2021

Future metrology research and innovation funded under Horizon Europe should be framed within and contribute to the future EU priorities. As an enabler across sectors and across disciplines, metrology solutions touch on all six priorities pursued by the Von der Leyen Commission, as Table 2 illustrates.

Table 2: Role of metrology in the context of the priorities of the Von Der Leyen Commission

Priority	Illustrations of Role of Metrology
European Green Deal	Provision of metrics for achieving climate neutrality
Economy that Works for People	Innovative and more accurate measurement tools are integral to a successful plan to fight cancer
Europe Fit for Digital Age	Central to standard-setting for 5G networks and digital services
Protecting our European Way	Essential to provide confidence in a fully-functioning

of Life	Schengen Area to reinforce the European approach to customs risk management
Stronger Europe in the World	Underpins Europe's role as a standard setter in leading a strong, open and fair trade agenda and a functioning Emissions Trading System
New Push for European Democracy	Ensuring standard to protect Europe against covert external interference

In a specific European context, metrology ensures that measurements made are traceable to internationally agreed definitions and measurement standards. This is the basis of national and international metrology systems that create the accurate, reliable and trustworthy measurements that underpin a wide range of economic activities and public services, covering the entire internal market within **an economy that works for people**. This concerns safety of products a consumer wants to buy as well as financial services; metrology enables each financial trade to be accurately time-stamped to provide traceable evidence of transactions and ensure compliance with European financial regulations.

Achieving **climate neutrality by 2050** will require clear measurement capabilities in remote sensing (such as Earth observation), environment and energy. More specifically, the policy areas of the Commission priority **the European Green Deal** are all directly related to metrology challenges. Accurate and traceable measurement capabilities enable robust environmental monitoring of the state of the climate. They also support the effective design and enforcement of environmental regulations by providing trustworthy data for the climate variables that support the Paris Agreement on Climate Change and for environmental parameters such as air and water quality.

As regards energy, measurement science will for instance be essential to support the implementation of the transition to renewable fuels. In a low carbon future, understanding the magnitude, timescale and impact of climate change will be central. This requires accurate and reliable monitoring of all climate variables over the long timescales needed to detect and understand climate trends.

Furthermore, metrology should underpin fit for purpose environmental regulation, such as on water or air pollution, including monitoring and enforcement. Beyond energy and environment, policy areas of the Green Deal such as **sustainable industry, sustainable mobility, and biodiversity** will all need a modern and capable metrology system.

To foster **a Europe Fit for the Digital Age**, accurate state-of-the-art measurement capabilities in NMIs and DIs will enable modern digital services such as 5G but also all emerging digital technologies, such as quantum or artificial intelligence.

As metrology is an enabler of all scientific and technological fields, improvements in metrology capabilities can accelerate scientific advancement and industrial developments to help address challenges related for example to health, environment, climate change, social protection and cultural heritage. Any future European metrology initiative for joint research and innovation would therefore need to create and exploit linkages with several other initiatives, within and beyond Horizon Europe.

In **Horizon Europe**, metrology is part of the research and innovation activities funded under the Pillar II Cluster Digital, Industry and Space as the robust accurate measurements provided by metrology make a critical contribution across manufacturing sectors, particularly to high-precision manufacturing of high-value-added products such

as aerospace, high-performance ICT and space equipment and pharmaceuticals. However, the use of robust accurate measurements is much wider than this and therefore the candidate European Metrology Partnership is relevant to a wide range of other European Partnerships and policies.

For instance, better metrology systems and measurement capabilities will make a direct contribution to the rolling out of 5G applications and to the installation and operation of smart electrical grids and therefore serve the objectives of the Partnership for Smart Networks and Services and the Partnership for Clean Energy Transition. Metrology is also important to ensuring accurate measurements in health diagnostics and delivery and therefore synergies can be explored with partnerships related to the use of health technologies in health, i.e. the Innovative Health Initiative and the Partnership for Large-scale innovation and transformation of health systems in a digital and ageing society.

More generally, complementarities will need to be built with envisaged European Partnerships under Horizon Europe as regards:

- digital intensive industries, such as Made in Europe as regards discrete manufacturing;
- Processes4Planet (previously called Climate Neutral and Circular Industries) as regards monitoring of CO₂ emissions and air pollution in general;
- Key Digital Technologies; Artificial Intelligence, data and robotics;
- Towards zero-emission road transport (2Zero); Safe and Automated Road Transport as regards connected driving and Clean Aviation.
- Synergies could also be explored with the Innovative Health Initiative and the Partnership for Large-scale innovation and transformation of health systems in a digital and ageing society.

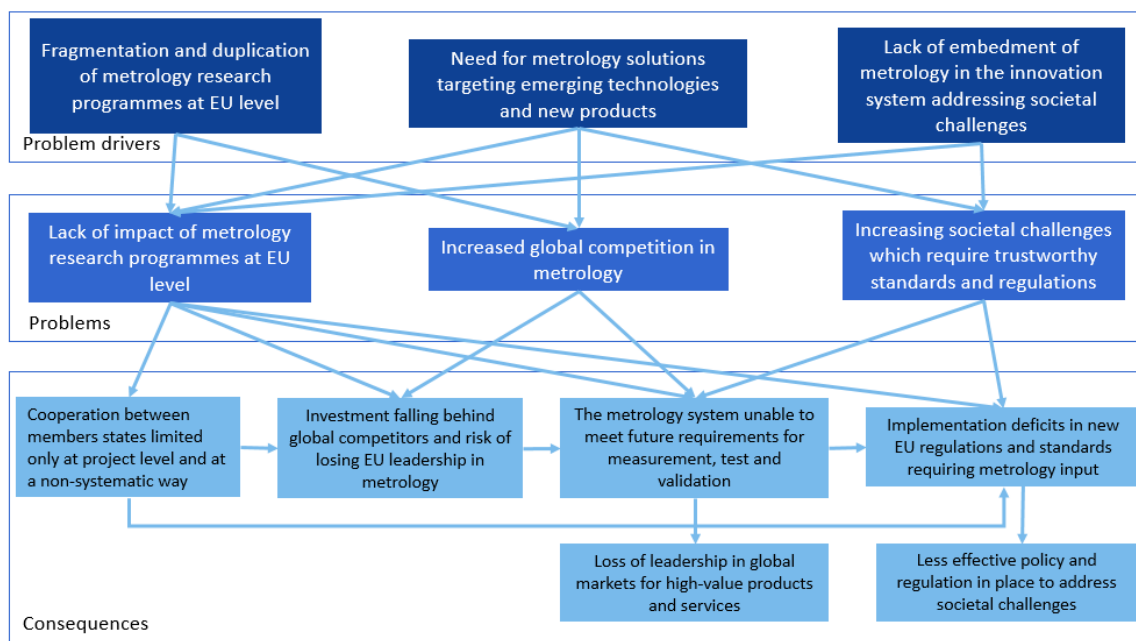
Beyond Horizon Europe, complementarities are also needed with other European programmes to support the deployment of metrology solutions such as with the Connecting Europe Facility, the Digital Europe Programme, or the LIFE environmental programme.

Finally, any future metrology initiative for joint research and innovation should fully take into account the regulatory and standardisation framework and work in close collaboration with the public authorities in charge.

2. PROBLEM DEFINITION

Taking into consideration the challenges the sector is facing and the current scientific, technological and economic position of Europe in the field as well as EU priorities, a set of problems and problem drivers were identified. Figure 6 shows a problem tree portraying problems, their drivers and consequences. The first problem focusses on lessons learnt out of FP7 and Horizon 2020 to increase impact of research and innovation in metrology. The second and third problem address challenges from outside which metrology researchers are facing much more in future.

Figure 6 - Problem tree for the initiative on metrology



2.1. What are the problems?

2.1.1. Problem 1: Lack of impact of metrology research programmes at EU level

The lack of impact at programme level was identified as a general problem with Article 185 initiatives in the horizontal evaluation of partnerships under Horizon 2020⁵³.

In the case of metrology, this has arisen because of the bottom-up approach of the partnerships to date. Metrology in Europe is implemented by NMIs. Dedicated support under the Sixth and Seventh Framework Programmes as well as Horizon 2020 has made significant progress in terms of coordination and integration of the activities of these national institutes.

To date, integration at European level has been focussed on pooling of national resources only at individual project level through organisation of calls. While this bottom-up approach has demonstrated the openness of national institutes to integrate their activities, it lacks the directionality required for metrology to impact effectively on policy-making processes. In this regard, the interim evaluation of the EMPIR Programme⁵⁴ highlighted the need to strengthen the strategic component (namely the contents of work programmes) to support policy in relation to the Single Market and to respond to major societal challenges.

There are certainly examples of individual metrology projects that demonstrate the potential for metrology to achieve policy impact. However, they are limited to individual projects.

⁵³ Impact assessment of Horizon Europe, Commission Staff Working Document, SWD(2018)307

⁵⁴ Expert Group report, Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR), https://ec.europa.eu/research/evaluations/pdf/emrp-empir_expgrp_report_final.pdf (2017), p.5.

- The HUMEA⁵⁵ project has focussed on knowledge transfer and reduction of duplication of metrology capacity in ten countries in the specific field of calibration for relative humidity. This is relevant for a range of industries and applications, and in particular for measuring atmospheric gases, which has a direct link to climate change variables. However, as an individual project launched from such a bottom-up call, its capacity to influence policy processes is limited. It does, at the same time, illustrate how a future metrology initiative could, through a more top-down strategic approach targeting policy challenges, impact on the Green Deal adopted at European level in December 2019 by contributing to meeting the new targets and new priorities set.
- The Bio-Stand⁵⁶ project has addressed measurement for in-vitro diagnostics. As a stand-alone project, it has only limited policy impact. However, a top-down strategic approach reflected in a work programme would enable rapid programmed actions by metrology institutes at European level and so make it efficient to deploy capacity for testing and analysis. Moreover, a more programmatic approach would speed up the European response to urgent issues such as the COVID-19 pandemic.
- In the area of 5G networks, where it is estimated that subscriptions will grow from EUR 6 million in 2019 to EUR 319 million in 2024, individual projects⁵⁷ have been funded by EMPIR. However, these isolated efforts are insufficient to meet the need for strategic capacity building in order to deploy 5G networks efficiently across the EU. 5G compatible devices will require EU wide standardised measurement procedures for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices.

In summary, there is a problem of lack of policy impact because the bottom-up focus of the partnerships to date has hindered the development of a portfolio approach to project selection in response to top-down identification of programming priorities.

Stakeholder opinion

The vast majority of the participants in the public consultation⁵⁸ (86%) representing academia, company/business organisation, EU citizens and public authorities believes that the new initiative in metrology needs or fully needs to have a higher impact of research programmes. By breaking down the responses to the sub-groups of stakeholders, representatives of company/business organisation agreed with that statement at 98% while the lowest percentage (78%) was observed among the participants who responded as EU citizens.

The majority of the participants in the public consultation (69%) consider that the new initiative in metrology is needed or fully needed to be more responsive towards EU policy objectives. Only 11% considered that it is not needed or not needed at all. No significant differences were observed between the different groups of respondents.

⁵⁵ EMPIR Project number: 15RPT03, www.humea-empir.org

⁵⁶ <https://www.lgcgroup.com/our-programmes/empir-bio-stand/>

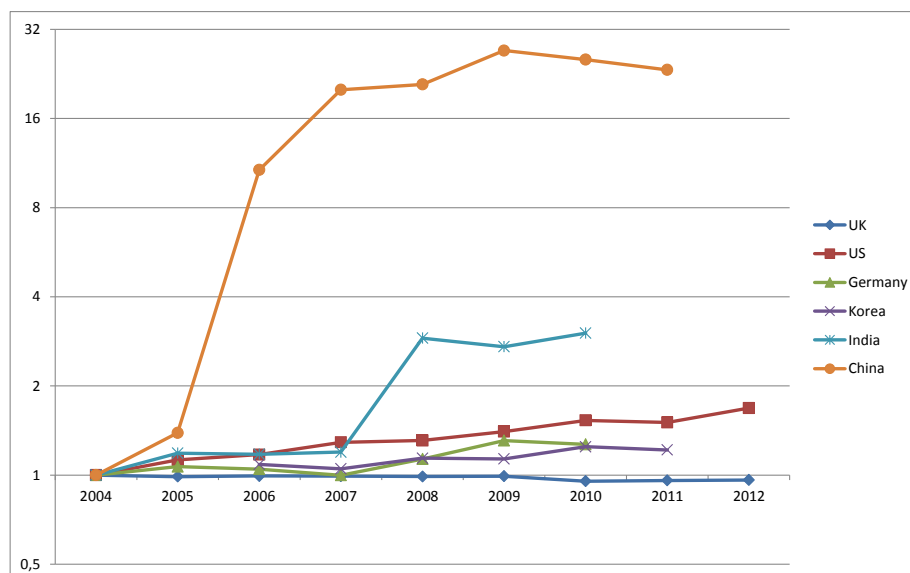
⁵⁷ Survey by Ericsson, June 2019, <https://www.statista.com/statistics/521598/5g-mobile-subscriptions-worldwide/>

⁵⁸ The open public consultation was run between September and November 2019.

2.1.2. Problem 2: Increased global competition in metrology

As the graphic below illustrates, under-investment in metrology in Europe compared to the rest of the world is a long-standing problem.

Figure 7: Investment in metrology, comparison of change⁵⁹



Source: Euramet

The above figure shows the situation which the current initiative EMPIR was facing at its launch in 2014. The competitive push from other global players, such as US, China and India continues today, puts at risk EU position against its global competitors. In the last decade, US, China and India increased their investments into metrology by 60%, 50% and 52% respectively. Investments into European institutes remained relatively static and did not respond to new and increasingly important research fields. The inadequate level of investment, coupled with fragmentation of metrology capabilities in Europe, has caused it to be distributed too thinly, with a lack of strategic focus.

This problem is illustrated, for example, in the area of electricity and magnetism. These are fundamental disciplines in metrology with about 50 different electrical quantities. In 2015, only nine countries had measurement capability for any electricity and magnetism quantity. Only five institutes both receive traceability as well as providing it, while the majority only receives traceability.

By contrast, their substantially higher levels of overall investment have allowed our competitors to target metrology funding on strategic priorities via centralised structures that provide for engagement with stakeholders along the metrology value chain. As mentioned earlier, US metrology investment in quantum science is more than USD 160 million annually. In China in 2018, the budget of the national metrology institute increased by EUR 50 million to EUR 180 million to support dedicated investment in infrastructure development. By comparison, PTB, the national metrology institute in Germany and the largest NMI in Europe, has a total operating annual budget of EUR 200 million.

⁵⁹ Rate of change of expenditure on national metrology systems (Source: EURAMET).

This disadvantage arises in part from the fragmented nature of metrology investment across Europe. Metrology systems are funded directly by governments and implemented by dedicated national institutes. Creating, maintaining and further developing metrology capabilities (physical infrastructure and skilled metrologists) and conducting metrology research within NMIs and DIs have high fixed costs which, with fairly static national metrology budgets, limit individual NMIs/DIs abilities to respond effectively to new needs. Moreover, the national agencies responsible for public funding in support of strategic objectives related to innovation and societal challenges are not directly engaged in metrology. Similarly, market operators avail of their services passively because they are mainly involved in the outputs of metrology as end-users and less in the development of new metrology services.

While there is involvement of the different players in project definition, implementation and exploitation, the metrology community does not significantly engage with other actors at the level of programme development. This means that there is no formal forum for industry to articulate its expectations at European level as to where research investment in metrology should be prioritised. While efforts in this direction have been made in recent years, such as through contacts with the Factories of the Future Public-Private Partnership under Horizon 2020, this articulation has remained weak. Hence, there is no clear link between the programme development and industrial investment in subsequent stages along the metrology value chain. As result, the capacity of metrology to contribute to the development of high-quality new products and services is sub-optimal.

Stakeholder opinion

The vast majority of the participants in the public consultation (87%) representing academia, company/business organisation, EU citizens and public authorities agreed or fully agreed that the new initiative in metrology needs to make a significant contribution to enhance the role of the EU in comparison to other global players in metrology research. No significant differences were observed among the different stakeholder groups, with the percentage of those agreeing or fully agreeing ranging from 80% to 90%.

2.1.3. Problem 3: Increasing societal challenges which require trustworthy standards and regulations

Europe is facing an increasingly rapid rate of social transition, such as to respond to climate change, environment, energy, health, and safety of products. This imposes new demands on the metrology system to contribute to meeting new societal challenges by providing guarantees to citizens and society as a whole as regards the trustworthiness of standards and regulations.

Addressing new challenges and/or improving policy responses to existing challenges place new demands on the metrology system – in terms of increased accuracy of measurements, measurement of new parameters and faster and affordable measurement tools. There are already cases where metrology has responded to the challenge, such as the projects to respond to the new measurement requirements under the Water Framework Directive⁶⁰. It has been estimated that 50 EU regulations and directives

⁶⁰ <https://opus4.kobv.de/opus4-bam/frontdoor/index/index/docId/38623>

affecting energy, environment, climate change and public health depend on metrology research outcomes⁶¹.

The “Low Carbon Economy” scenario developed in the BOHEMIA study⁶², where energy and environmental aspects are central, highlights further the important role of metrology. In a low carbon future, understanding the magnitude, timescale and impact of climate change will be central. This requires accurate and reliable monitoring of all climate variables over the long timescales needed to detect and understand climate trends.

More broadly, as recognised by the United Nations Industrial Development Organization (UNIDO), addressing societal challenges and sustainable development goals in climate change, environment protection, sustainable energy and healthcare relies on metrology capabilities for the robust identification and assessment of risks, and the design and implementation of effective policy, regulation and standards to mitigate them⁶³. Accordingly, the link between metrology and regulatory developments needs to be strengthened in order to rapidly provide the measurement infrastructure and systems for the society to comply and use the new frameworks. If not, the consequences for metrology would be detrimental because the metrology would not be fit for purpose.

In a landscape where policy needs evolve fast, such as response to pandemics or to climate change, the current gap between the metrology capacity development, and regulation and standards setters will only increase without actions to strengthen the integration of metrology. The rate of social transitions is also highlighted in the Commission’s orientations paper for the Strategic Plan on Horizon Europe, in which metrology is specifically mentioned as a potential area for intervention⁶⁴.

In this regard, the 2017 interim evaluation of the EMPIR initiative recommended that a future metrology initiative should have a particular focus on the contribution of metrology to societal challenges.

Stakeholder opinion

The vast majority of the participants in the public consultation (87%) representing academia, company/business organisation, EU citizens and public authorities considered relevant or very relevant to optimise contributions to future standards and regulations at EU level. No significant differences were observed among the different stakeholder groups, with the percentage of those agreeing or fully agreeing ranging from 84% to 88%.

⁶¹ Source: EURAMET

⁶² Transitions on the Horizon – Perspectives for the European Union’s future research and innovation policies – Study, <https://op.europa.eu/en/publication-detail/-/publication/21d456ff-6eb5-11e8-9483-01aa75ed71a1/language-en/format-PDF/source-91686077>, 2018.

⁶³ UNIDO, Bernardo Calzadilla Sarmiento, Director, Department of Trade, Investment and Innovation, Metrology in Support of the Sustainable Development Goals

<https://www.bipm.org/utis/common/pdf/CGPM-2018/Presentation-CGPM26-Sarmiento-SDG.pdf>

<https://www.unido.org/news/advancing-sdgs-through-quality-and-standards>

https://www.unido.org/sites/default/files/2017-05/SDG_Metrology_brochure_FINAL_pages_0.pdf

⁶⁴

https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_orientations-he-strategic-plan_122019.pdf

2.2. What are the problem drivers?

2.2.1. Problem driver 1: Fragmentation and duplication of metrology research programmes at EU level

A strategically fragmented metrology research system reduces the effectiveness and efficiency of the Single Market and the Innovation Union. The efficient access to markets depends today on the local access to calibration and certification services, which in turn will be completely defined by the capacity of the metrology system in a certain country. There is no European entry point for specific applications on a European level, although the European association, EURAMET, can function as a gateway. However, EURAMET does not provide metrology services for specific applications directly.

EMRP and EMPIR partnerships have made progress in bringing metrology research resources together by focussing on project level research collaboration. Certainly, EMPIR has leveraged more than 50% of the research budget of national programmes and has successfully created integration momentum via the 169 collaborative research projects directly funded under the initiative. However, it has been mostly limited to project collaborations, with the focus of projects still being driven by national priorities. Any European-level metrology capacity created in the initiative is solely bottom-up from a diverse set of projects and thus cannot be self-maintained in the longer term.

Under EMPIR, 28 national metrology systems in Europe (23 Member States and 5 associated countries) act under national mandates, addressing gaps in some Member States. The EURAMET members also address some overlaps and duplication of metrology research capacity, but still on a fragmented level through initiatives of the individual Member States. EURAMET has for example registered 1223 bi- or multilateral projects (from 1988 to 2010) for cross-border collaboration, of which 150 are still active today⁶⁵.

The current fragmented approach to research at strategic level does not provide the efficiency required to respond to the increasing demands on the metrology system in Europe. This inhibits Europe's ability to provide the metrology infrastructure required to capitalise optimally on all challenges Europe is facing, such as supporting emerging technologies for the benefit of European competitiveness globally, and to address major societal challenges for the benefit of European citizens.

After the 2017 EMPIR mid-term evaluation, a process for streamlining cooperation at the level of devising the work programme of the partnership has already started: six European Metrology Networks (EMNs)⁶⁶ have been initiated from a larger list of potential areas identified in which EURAMET members would be able to invest in joint capacities. Additional networks are foreseen to be established in the coming years. Following a written consultation of Member States launched on 18 March 2020, Member States confirmed the need to move out of the currently fragmented and bottom-up way of research cooperation and to strengthen EMNs as a model for the future.

Stakeholder opinion

⁶⁵ <https://www.euramet.org/technical-committees/tc-projects>

⁶⁶ There are currently six European Metrology Networks (EMNs): Mathematics and Statistics, Laboratory Medicine, Quantum Technologies, Smart Electricity Grids, Energy Gases, and Climate and Ocean. Further networks can be developed in the future. On the current networks, see <https://www.euramet.org/european-metrology-networks/>

The vast majority of the participants in the public consultation (82%) representing academia, company/business organisation, EU citizens and public authorities agreed or fully agreed that collaboration between public actors, namely NMIs, is too limited. Minor differences were observed among the different stakeholder groups, with the percentage of those agreeing or fully agreeing ranging from 75% (EU citizens) to 90% (company/business organisation).

2.2.2. *Problem driver 2: Need for metrology solutions targeting emerging technologies and new products*

The increasingly rapid speed of development and adoption of emerging technologies poses a major technological challenge for Europe.

The report on the 100 Radical Breakthroughs for the Future⁶⁷ identifies 45 technologies that are currently at a low level of maturity but are expected to develop fast. Among the top seven fast moving emerging technologies, metrology will play an important role in enabling rapid market take-up of at least five: neuromorphic chip, biodegradable sensors, hyperspectral imaging, neuroscience of creativity and imagination and 4D printing.

Enabling emerging technologies imposes additional pressures on the metrology system and, in some cases, requires entirely new types of measurements. This is already evidenced with quantum and bio-based technologies, for example, which require new metrology capabilities, skills and infrastructure. The increasing significance of quantum technologies is demonstrated by the four-fold increase in private investment in the sector in 2017-2018 compared to 2015-2016⁶⁸.

Emerging technologies also pose challenges in terms of capitalising on opportunities to develop the metrology system itself. If these opportunities can be realised, they offer potential solutions for the long-term development of a European-wide metrology system.

Metrology should also support producers and service providers in adapting to the new market opportunities created through early adoption of emerging technologies. It enables businesses to deliver high quality products, by providing quality assurance. The current initiative EMPIR has had a specific objective of leveraging EUR 400 million of increased private turnover through sales of newly developed products and services. At the mid-term evaluation, the initiative demonstrated that this leverage was on track to be achieved. In the future, these figures will increase. For example, global turnover is estimated to EUR 35 billion per year for the sensor industry, with about 100 sensors per person on Earth⁶⁹. New physical and digital systems must be underpinned by robust metrology to ensure the data used are accurate and reliable. Digitalisation and automation of manufacturing, transport and consumer products will for instance be a driver for a growth at a rate of 8% to 10% every year. Intervening in metrology capabilities will have a direct impact on these growth rates⁷⁰.

⁶⁷ https://ec.europa.eu/jrc/communities/sites/jrccties/files/ec_rtd_radical-innovation-breakthrough_052019.pdf

⁶⁸ E. Gibney, Nature 574, 22-24 (2019)

⁶⁹ <https://www.ama-sensorik.de/en/association/sector-information/>, and AMA Verband: Was bringt 2017 für die Sensorik und Messtechnik? (<http://www.elektroniknet.de/markt-technik/messen-testen/was-bringt-2017-fuer-diesensorik-und-messtechnik-137356.html>)

⁷⁰ https://cdn.southampton.ac.uk/assets/imported/transforms/content-block/UsefulDownloads_Download/47523AE5DBC34BFF86A5BAA8BE59558C/Nigel%20Rixrevised.pdf

Metrology research creates new metrology knowledge, tools and techniques that feed into and stimulate innovation in industry and a wide range of service sectors including healthcare as mentioned above, communications, financial services, environmental monitoring. For instance, the increased digitalisation and automation of a wide range of services such as transport, healthcare and energy infrastructures also rely on complex sensor systems and automated data processing and analysis.

The obstacle in Europe to capitalising on the enabling role of metrology in relation to emerging technologies is that currently, NMIs do not engage adequately with innovators seeking to capitalise on emerging technologies to develop new high-quality products and services.

Stakeholder opinion

The vast majority of the participants in the public consultation (85%), representing academia, company/business organisation, EU citizens and public authorities agreed or fully agreed that the existing innovation gap hinders the EU from ensuring a European-wide metrology system applicable to emerging technologies and able to support their industrial deployment. Minor differences were observed among the different stakeholder groups, with the percentage of those agreeing or fully agreeing ranging from 78% (EU citizens) to 95% (company/business organisation).

2.2.3. Problem driver 3: Lack of embedment of metrology in the innovation system addressing societal challenges

Metrology has the capacity to play an important role in developing fit for purpose measurement solutions to address societal challenges in areas such as health, environment and energy. Accurate measurements provided by metrology are essential to well-designed policy and regulation. Public policy, and any resulting regulation, is increasingly directed at well-defined societal challenges in health, climate change, environment, energy etc.

For example, variable renewable energies require a smart grid to be useable for consumption. The estimated renewable capacity in the EU27 has increased by 78% from 2010 to 2020⁷¹, which shows the increased need of traceable metrology for smart grid installation. Globally⁷², the market value for smart grids will increase from USD 20 billion to USD 60 billion from 2017 to 2023; in Europe, it will increase from USD 5.4 billion to USD 15.4 billion. Against this background, policy-makers require reliable and better evidence to identify and assess risks and to design and implement effective policy, regulation and standards to mitigate them. Reliable and better evidence includes reliable assessments of physical, chemical and biological parameters.

As another example, in environmental monitoring, metrology capabilities enable the assessment of the state of the climate and contribute to the design and enforcement of appropriate environmental regulations through providing reliable and trustworthy data for the essential climate variables that support the Paris Agreement on Climate Change and

⁷¹ European Commission Energy Market Data collected from S&P Global - Platts

⁷² Global smart grid market size by region 2017-2023, Statista, <https://www.statista.com/statistics/246154/global-smart-grid-market-size-by-region/>

for environmental parameters such as air and water quality. It links to directives such as the Water Directive⁷³, and to policy priorities such as the Green Deal.

However, the 2017 interim evaluation considered the contribution of metrology to addressing societal challenges to be insufficient. To date, the approach lacks the necessary industrial and academic breadth and depth of practical knowledge and experience available at European level to tackle such strategic issues

Under EMRP, 43 projects out of 119 projects dealt directly with regulations. Moreover, EMRP funded projects led to 739 contributions made to 379 standards committees and impacted directly on 103 draft standards. Under the EMPIR programme, 60% of CEN/CENELEC, ISO and IEC technical committees certainly engaged with EMPIR-funded projects. Furthermore, in 2014, a working group was established under the EMPIR programme to align metrology projects with CEN/CENELEC standardisation processes at the level of projects. While the group demonstrated its potential of formulating specific research needs, this group has currently a limited role regarding strategic priorities for future metrology programmes in research and innovation.

Moreover, engagement between metrology community and wider policy-making channels (at European and national levels) is lacking at present. This limits the capacity to ensure that the measurement requirements of policies are well-designed. It also hinders common understanding of emerging policy needs.

NMIs and DIs have expressed their commitment to work on societal challenges. However, EMPIR currently does not engage policy-makers or wider citizens' interests in its programming processes. As a result, NMIs lack the necessary awareness to ensure metrology plays its part in supporting the European response to societal challenges.

Unless NMIs open up programming processes at EU level through a wider range of stakeholders, the metrology community will remain peripheral to the European approach to addressing societal challenges. Addressing this need requires that standards setters are part of the process of metrology programme development and not only of collaboration at project level. Consultations on future metrology programming should systematically include regulators to increase their focus on where metrology can contribute to new regulations in addition to the implementation of existing regulations.

European metrology institutes provide chairs and vice-chairs for 36 of the 70 consultative committees of the International Committee for Weights and Measures (CIPM)⁷⁴, which have a direct influence in policy making on an international level. This provides a positive starting point for widening the reach of metrology R&I and for collaboration along the metrology value-chain to develop a better understanding of end-users needs under a potential future metrology initiative at European level.

Stakeholder opinion

The vast majority of the participants in the public consultation (89%) representing academia, company/business organisation, EU citizens and public authorities agreed or fully agreed that accelerated trusted validation and product quality assurance procedures

⁷³ Directive 2000/60/EC, https://ec.europa.eu/environment/water/water-framework/index_en.html

⁷⁴ Data from the Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR), European Commission July 2017, p. 31.

are needed for adoption of new technologies and products. No significant differences were observed among the different stakeholder groups, with the percentage of those agreeing or fully agreeing ranging from 85% to 93%.

2.3. How will the problem(s) evolve?

A patchwork of national metrology solutions across Europe has been a constant risk for the metrology community for 11 years during which Europe provided funding under the EMRP and the EMPIR programmes. Progress to address this risk was made according to the evaluation carried out in 2017⁷⁵. These programmes helped building metrology capacities in each Member State. Cross-border contacts have significantly increased overtime, but remained limited to the level of technical committees and to cooperation via projects.

If no further action is taken at EU level, the problems would evolve as follows:

- Larger NMIs in Member States would remain driving forces within their national mandates, but even those larger NMIs will remain peripheral in the wider research and innovators community at EU level.
- The lack of investments at present would eventually affect European competitiveness compared to other global players in the US and in China.
- Europe's concerted response to societal challenges would be hindered by the lack of involvement by NMIs.
- Over time, the situation would be likely to lead to even more suboptimal levels of research collaboration. NMIs would risk being more dependent on collaboration with metrology institutes outside Europe with implications for the new challenges related to the competitiveness of industries in Europe and the rapid change in energy supply, environment protection, health care and other public policy priority areas.
- A pan-European metrology chain for testing new emerging technologies would not be built up. Metrology research in Europe would be at risk of losing its current global leadership and would fall behind others. There would be a related risk that deployment of emerging technologies would be disadvantaged in Europe compared to other parts in the world, with standards and regulations not fit for purpose.

3. WHY SHOULD THE EU ACT?

3.1. Subsidiarity: Necessity of EU action

The public good character of metrology means that there are potentially significant economies of scale through pooling of research efforts. EU action helps realise these economies of scale. At the same time, the strategic importance of metrology for national governments in areas such as defence and security leads to a strategic need to retain competence at national level. For this reason, EU action needs to focus on promoting integration of national metrology research efforts.

⁷⁵ Final Evaluation of the European Metrology Research Programme (EMRP) and Interim Evaluation of the European Metrology Programme for Innovation and Research (EMPIR), European Commission July 2017.

By achieving a significant level of integration of national metrology efforts, EU action under the Seventh Framework Programme and Horizon 2020 has enabled Europe to establish global leadership in many fields of metrology. As metrology research grows in importance as an enabler of emerging technologies, other global regions are increasing significantly their metrology investments and targeting them strategically⁷⁶. EU action at this stage is needed, therefore, to maintain the momentum of integration so that it becomes embedded along the metrology value chain and so increases engagement of metrology stakeholders including regulators and standard setters, industry and societal end-users, as well as citizens. This is the key to achieving the long-term sustainability of integrated metrology research in Europe.

It is critical that such EU action is maintained now in order to achieve sustainability. Otherwise, as the 2017 mid-term evaluation points out, metrology efforts in Europe risk becoming fragmented again, with capacity building in smaller NMIs being stunted while larger NMIs conclude bilateral arrangements with their counterparts in other world regions, so undermining Europe's technological sovereignty.

Member States opinion

According to Member States, metrological questions are nowadays more complex (e.g. characterisation of nanomaterials, environmental samples, absence of reference methods, etc.) making challenging to address them individually. In addition, metrology is a cross cutting discipline, and will be able to bring benefits to all clusters only if action is taken at an integrated European level⁷⁷.

3.2. Subsidiarity: Added value of EU action

EU-level support to date has demonstrated the scope for fostering significant levels of integration of metrology research efforts across Europe. However, further efforts are required to enhance the quality of such integration. To date, integration has been driven by bottom-up, project level collaboration. With the growing importance of measurement in driving the advance of emerging technologies and in responding to societal challenges, metrology takes on a growing strategic importance in strengthening European competitiveness and in meeting the needs of citizens and society in general. This is seen in areas of rapid transformation such as industry digitisation, energy supply, public health and climate change.

To meet the need for strategic input effectively, it is essential to strengthen integration of metrology research in terms of directionality. Beyond 2020, the added value of EU action will arise from the development and implementation of a more strategic, programmatic approach to metrology research that deepens integration and targets research on areas of technological and societal priority.

Based on the integration progress achieved under the previous metrology initiatives, such a more programmatic approach could be established on a committed basis by the end of Horizon Europe, underpinned by an initiative at European level that provides the certainty needed for NMIs to commit long-term stable resources.

⁷⁶ Examples of relevant EMPIR projects: [https://www.euramet.org/research-innovation/search-research-projects/details/?tx_eurametctp_project\[project\]=1409](https://www.euramet.org/research-innovation/search-research-projects/details/?tx_eurametctp_project[project]=1409), [https://www.euramet.org/research-innovation/search-research-projects/details/?tx_eurametctp_project\[project\]=1614](https://www.euramet.org/research-innovation/search-research-projects/details/?tx_eurametctp_project[project]=1614)

⁷⁷ The feedback from Member States representatives of the corresponding ministry responsible for metrology was collected as part of the Inception Impact Assessment.

Metrology will also play an important enabling role in relation to Europe’s contribution to more than half the United Nations’ Sustainable Development Goals, as highlighted in Table 3.

Table 3 - Role of metrology in the context of the UN Sustainable Development Goals (SDG)

SDG	Illustrations of the Role of Metrology
3. Good Health and Well-Being	Supporting increased use of deep learning and big data in personalised medicine and medical imaging
6. Clean Water and Sanitation	Supporting accurate, reliable and trustworthy measurements in support of improved water quality
7. Affordable and Clean Energy	New metrology solutions can support the exploitation of fluctuating wind or solar energy through power-to-gas/hydrogen transformation for storage and transport
9. Industry, Innovation and Infrastructure	New tools and techniques enable industry to develop innovative instrumentation, sensors, analytical tools, systems and methods that underpin manufacturing and services Reliable and consistent measurement enables the functioning of complex global supply chains
11. Sustainable Cities and Communities	Accurate and traceable environmental monitoring to inform society about the state of the climate
12. Responsible Consumption and Production	State-of-the-art measurement capabilities that validate the performance and functionality of novel concepts, technologies, products and services
13. Climate Action	Definition of critical climate variables and essential ocean variables to enable environmental monitoring and effective design and enforcement of regulations that mitigate against pollution and climate change
14. Life Below Water	
15. Life on Land	Measurement technologies for conformity assessment of NOx vehicle emissions

Member States opinion

Several Member States underlined the importance of an integrated European metrology system for maintaining EU leadership in the field. Especially smaller Member States highlighted the role of a European metrology instrument for collaboration with metrology institutes from other Member States, especially larger ones, with larger research capabilities that they cannot directly fund themselves⁷⁸.

⁷⁸ Ibid

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives of the initiative

To address the identified problems three general objectives are proposed for the potential partnership initiative in metrology: one focused on scientific metrology capabilities and knowledge and one objective each focused on economic and social impact (see Annex 6).

The **scientific objective** is to *develop a sustainable coordinated world-class metrology system on a European level.*

This is intended to focus the initiative on maximising the quantity, quality and relevance of metrology research across Europe in the most efficient and integrated way and consequently eliminate fragmentation and duplication on metrology research efforts. The initiative should assert its long term global leadership in metrology through research and scientific excellence. To this end, a much closer alignment with other research and innovation programmes is essential. Only such alignment allows maximising the impact of investments into a metrology system.

The **economic objective** is to *ensure that state-of-the-art metrology capabilities are taken up directly by innovators in their ecosystems.* Inefficiencies would affect the smooth functioning of the Single Market, in particular the free movement of goods and services.

The aim of the economic objective is to overcome the current lack of participation by industry and other end-users in priority-setting for metrology research and to increase the take-up of metrology solutions in the development of innovative, high-value products and services by the end-users. The initiative will need to address emerging technologies in particular to ensure support for competitiveness. This will be an important factor in ensuring European leadership in global markets for these products and services.

The **societal objective** is to *increase the impact of metrology on societal challenges in relation to the implementation of policies, standards and regulations to make them fit for purpose.*

This objective is focused on ensuring that state-of-the-art metrology knowledge and capabilities are created, effectively diffused and adopted by standard setters, policy-makers and regulators to protect the public interest and public good at a European level. It will also address the increasing needs for regulation and standardisation derived from global challenges such as the climate change and the COVID-19 pandemic.

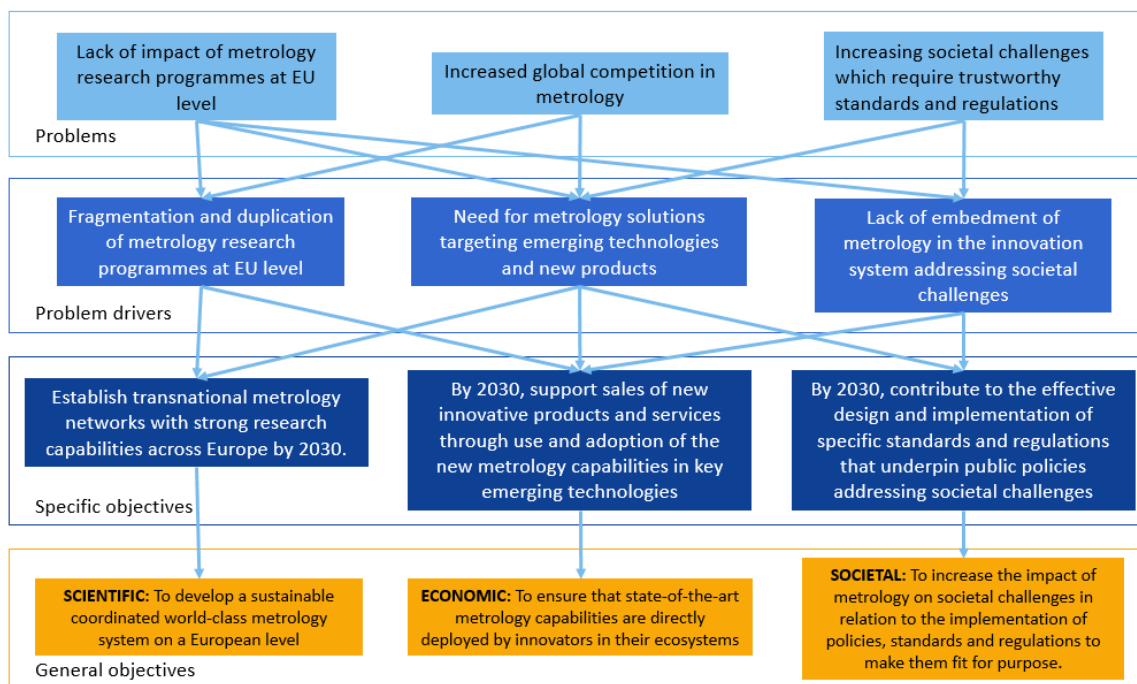
All Sustainable Development Goals are relevant for this initiative and those identified in Table 2 in section 1.3 would be impacted directly through the initiative.

4.2. Specific objectives of the initiative

In order to achieve the general objectives, three specific objectives are defined. These specific objectives respond to each of the problem drivers discussed in Section 2.2.

Figure 8 shows the specific and general objectives of the proposed initiative on metrology.

Figure 8: Objectives tree for the initiative on metrology



Three specific objectives are proposed that align directly with the three general objectives (as indicated) and with the scientific, economic and social impact domains of Horizon Europe.

Specific objective: Develop transnational metrology networks with strong research capabilities across Europe at least equal to the top global performers by 2030.

Build transnational metrology networks equipped with strong capabilities to undertake research in key application areas, to disseminate results and interact with the full metrology value chain across Europe. By 2030, the networks should function independently with no further need for a dedicated metrology initiative to maintain their research excellence.

In the proposed metrology initiative, the aim would be to minimise duplication and fragmentation through the establishment of transnational metrology networks across Europe⁷⁹. The measures of success would be the number of networks created and that the quality of the research outputs would be at least equal to the top global performers by 2030. European Metrology Networks should be transnational to ensure their findings are applicable to the majority of Member States for higher impact across the Single Market.

The calls under this proposed initiative will run until 2027, and the competitive calls will allow to create metrology networks with research capabilities. Through the creation of research excellence in the strategic areas covered, the networks will be able to seek other funding for their research once the last actions are ended in 2030. This objective would thus allow for an exit strategy for the initiative, in which there would not be a need for a dedicated initiative on metrology research. The fulfilment of the objective related to

⁷⁹ Examples of areas where European Metrology Networks could be established include advanced manufacturing, clean energy, environmental monitoring, food safety, laboratory medicine and smart electricity grids.

metrology networks would create shared metrology capacities between participating States. To maintain these shared capacities would be an incentive on its own to continue with cross-border collaboration in specific metrology research areas. In this way, the networks would develop the capacity to participate in consortia under framework programme calls thus mainstreaming their activities and so no longer requiring a dedicated partnership arrangement under Article 185. The target date is 2030 because at that date, the results of all projects launched under the initiative, up to and including 2027, will be available.

Specific objective: By 2030, support sales of new innovative products and services through use and adoption of the new metrology capabilities in key emerging technologies

Align the metrology networks with other investment agendas (e.g. Horizon Europe, InvestEU, Connecting Europe Facilities (CEF) etc.), increase the industrial participation to 40% and demonstrate a yearly turnover increase compared to EMPIR of EUR 50 million per year on average by 2030.

Aligning the European Metrology Networks (EMN) with other investment sources and outreaching to external entities outside the regular network will ensure the financial sustainability of metrology research in the long term. The measure of success will be based on the level on which future networks are attracting funding from these investment agendas, the number of participants outside the networks, the leverage factor of private investments compared to public funding and on the level of metrology research findings contributing in the implementation of these agendas, e.g. in health, industry, climate change, energy, technology etc. If the networks are not successful, a truly European solution with a much higher impact on European budgets needs to be developed. To achieve this objective, the involvement of private sector actors in developing the strategic orientations of the initiative will be critical. Accordingly, the preferred option will need to provide a strong incentive for private sector actors to engage and participate.

Specific objective: By 2030, contribute fully and effectively to the design and implementation of specific standards and regulations that underpin public policies addressing societal challenges

Transfer of knowledge and projects results towards standardisation bodies and legislators. By 2030, all EU-level legislation requiring metrology infrastructure for its implementation should be supported directly or indirectly by the initiative or by a European Metrology Network (EMN)⁸⁰.

The successful implementation of the Single Market is based on standardised products and services that are traded/applicable to the majority of the Member States (if not all). Thus the input of metrological research to standardisation and regulation committees is of utmost importance. The measure of success will be in terms of to the number of metrology project contributing to specific standards and regulation committees and especially those focused on key societal challenges in climate, environment and health. The regulation support should follow the Innovation Principle of which metrology should be an integral part⁸¹.

⁸⁰ There are currently six European Metrology Networks (EMNs): Mathematics and Statistics, Laboratory Medicine, Quantum Technologies, Smart Electricity Grids, Energy Gases, and Climate and Ocean. Further networks can be developed in the future. On the current networks, see <https://www.euramet.org/european-metrology-networks/>

⁸¹ https://ec.europa.eu/info/research-and-innovation/law-and-regulations/innovation-friendly-legislation_en

4.3. Intervention logic and identification of targeted impacts for the initiative

How would success look like?

Delivery on the specific objectives of the initiative is expected to translate in practice into the following impacts:

Scientific impacts

- Integrated European metrology system beyond 2030
- Improved engagement with and participation in the metrology system across the innovation and policy-making systems by 2030
- Europe provides metrology solutions by 2030 at least equal to the top global performers

Success would be achieved if the initiative delivers a European metrology system that by 2030 integrates the efforts of NMIs and DIs across Europe so that the system provides metrology solutions at least equal to the top global performers, therefore removing the need for a further partnership under Article 185 TFEU. Such a system would engage stakeholders along the metrology value chain so that awareness of the contribution and potential of metrology across the innovation and policy-making systems is enhanced. Such a self-sustaining and broadly-based system would make Europe a world-leader in cutting-edge metrology capabilities and metrology-related research.

Economic/technological impacts

- Sales in 2030 of innovative products and services due to metrology programmes' and projects' outcomes, leading to growth of innovative businesses that sell or use measurement equipment
- Sales in 2030 of innovative products and services due to metrology programmes' and projects' outcomes, leading to innovative products that contribute to sustainable economic growth

Success would see a much wider engagement between the metrology research community and stakeholders along its value chain, such that appropriate services and technology applications would be delivered effectively. This would need to include private sector actors in order to realise the downstream economic and technological impacts.

This would also see a high level of engagement with innovators in particular, enabling metrology to play an important role in the delivery of new products and services embodying appropriate standardisation and regulatory characteristics. In this way, metrology would support European competitiveness through high quality goods and services, thus providing strong incentive for private sector actors to engage and capitalise on the competitive opportunity..

Related to this, success would see metrology playing an important role in ensuring the reliability of innovations arising from new and emerging technologies.

Environmental and societal impacts

- Metrology research and innovation contributes widely to European regulations and policy and the standards that underpin them by 2030

Environmental impacts

The initiative would play an important role in relation to Europe's climate action goals, including the goals of protecting the environment. Achieving wide societal buy-in to the changes in behaviour required to meet Europe's climate action goals and to ensure environmental protection at the same time would require a robust and trustworthy measurement system. Metrology would be essential in quantifying accurately the relevant climate variables in this regard. It can in future also play an important role in the implementation of the Water Directive. As metrology would increase its engagement with end-users and citizens along its value chain, the scope of its contribution to climate change variables would broaden.

Societal impacts

More widely, the initiative would play an important role in helping to address societal challenges. The societal impact of the initiative would have a wide span covering, inter alia, more advanced public health solutions, improved quality of life, notably in urban areas, and more responsible production and consumption.

As engagement in metrology research priority setting would be broadened to include stakeholders along its value chain, including standard-setters and regulators as well as end-users and citizens, metrology research would become more aligned with general research addressing societal challenges, allowing it to contribute to more rapid policy evolution based on mutually agreed and measurable variables. This in turn would inspire higher levels of trust from citizens and enhance adaptation of behaviour to support greater societal impact.

Stakeholder opinion

The vast majority of the representatives of the corresponding Member States ministries who participated in the inception impact assessment considered an initiative in metrology very relevant in addressing societal impacts. In the same public consultation, it was also highlighted that a higher societal impact would be achieved with greater involvement of private stakeholders, but still keeping as a priority addressing the societal challenges over the mere economic output.

4.4. What is needed to achieve these objectives – Key functionalities

Given the focus of the impact assessment on comparing different forms of implementation, the identification of “key functionalities needed” facilitates the transition from the definition of the objectives to what would be crucial to achieve them in terms of implementation. These functionalities relate to the type and composition of actors that have to be involved, the range of activities that should be performed, the degree of directionality needed and the linkages needed with the external environment.

4.4.1. Type and composition of actors to be involved

In order to achieve the objectives for metrology, all stakeholders in the metrology value chain must be involved in the development and implementation of the programme. Lessons from past evaluations of EMPIR and EMRP showed that it is not sufficient that they participate at the level of projects. In addition to the research sector, these actors include policy-makers in national ministries, standards-setters, regulators, industry players and societal end-users.

In order to secure the commitment of stakeholders along the metrology value chain, support for metrology will need to be inclusive at all stages of its programming and implementation. It will need to create the conditions for openness to engage with new stakeholders in the development of future programmes so that its reach extends beyond the NMIs and DIs. Transparency and openness will also be important to build credibility with other actors in research and innovation as well as downstream close-to-market actors, including standards setters and regulatory authorities.

4.4.2. Type and range of activities needed

In order to achieve the specific objectives set for the initiative, previous experience with the EMRP and EMPIR partnerships showed that **activities based on long-term stable investment by the partners** will be needed. These should provide the basis for a sustained focus on addressing a number of key priorities at the level of project implementation.

To ensure an appropriate level of Integration of Research and Innovation Strategies, it will be important that the form of support for metrology has a strong strategic and programming orientation in order to target metrology efforts at relevant research and innovation agendas.

4.4.3. Priority setting system and level of additionality required

For the initiative to be able to deliver on its specific objective of achieving long-term sustainability, strengthening and deepening the focus of metrology research on emerging technologies and major societal challenges to be tackled in future regulations and standards at EU level is also essential. This requires an approach that facilitates a clear strategic orientation as opposed to a scatter-gun option that is based on bottom-up project selection without prioritisation or top-down strategic guidance.

As regards the degree of additionality needed⁸², there are two dimensions involved here based on lessons learned from FP7 and Horizon 2020. Firstly, any support at European level must demonstrate that it can achieve greater impact than the NMIs would achieve acting alone at national level. Secondly, it must achieve greater downstream impact along the metrology value chain in terms of ensuring that Europe maintains world leadership in standard setting and regulation and in investment in globally competitive new high quality products and services. Additionality is therefore critical to ensuring a sustainable long-term outcome for the metrology initiative.

4.4.4. Coherence needed with the external environment

For the initiative to be successful, due account should be taken of relevant elements of its operating, programmatic, policy and regulatory environments. These include synergies with other parts of Horizon Europe and with national and regional programmes, coherence with relevant regulatory and standardisation frameworks and coherence with wider policy environments.

Synergies with Horizon Europe: The cluster approach that underpins Pillar II of Horizon Europe encourages a cross-sectoral approach that facilitates pooling efforts to tackle emerging technological issues and address major societal challenges at programme

⁸² Additionality here is not intended in the context used in the Strategic Plan for Horizon Europe.

level. Given that metrology is a cross-sectoral discipline, it will be relevant across all six clusters under the second pillar of Horizon Europe. Accordingly, the architecture of the initiative must facilitate a programmatic approach that allows the initiative to contribute to the maximum to the Horizon Europe strategic objectives.

Coherence with Public-Private Partnerships: The public-private partnerships envisaged under Horizon Europe have a near-to-market focus. As an upstream, cross-sectoral discipline, metrology needs support that is structured to facilitate dovetailing with the objectives of other partnerships. In this way, synchronised and cross-cutting calls could be envisaged with other partnerships that would facilitate downstream take-up of strategic metrology capability. A future metrology partnership should provide for a structured and systematic approach to communication between those preparing metrology research programmes and industries represented in future public-private partnerships.

Synergies with National and Regional Programmes: To be policy-relevant, the metrology initiative will need to be open to engagement at policy level with competent national ministries and, through them, regional authorities responsible for programme development and implementation.

Coherence with relevant Regulatory and Standardisation Frameworks: Metrology is essential to ensuring new regulations are fit for purpose and address the leading ‘state of the art’ in the relevant field. Metrology should also have a strong influence on the development and revision of standards. Accordingly, the future metrology initiative needs to ensure full coherence with regulatory and standardisation frameworks at EU level, including engagement of regulators and standards-setters in informing the strategic priorities of the initiative.

Coherence with Wider Policy Environments: Metrology is a global-level discipline, with numerous international agreements and conventions. Accordingly, the partnership must have the capacity to engage in global-level forums beyond those which are pivotal for metrology as such, including, for instance, the World Health Organisation in the current COVID-19 crisis. It must also have the capacity to engage and provide expertise the inter-governmental domain within Europe and between Member States and third countries. Given its roots in measurement and accuracy, it should also be coherent with the need of citizens for confidence in the robustness of measurement systems that are integral to their daily lives.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

This section describes the specific functionalities that could be provided under the baseline scenario of traditional calls and the different options of different types of European Partnerships.

5.1. What is the baseline from which options are assessed?

The baseline scenario used in this impact assessment is a situation without a partnership and only traditional calls of Horizon Europe. Given that there is a predecessor partnership as well as other funding sources in the area, these will continue generating effects even if there is no new partnership. In particular it is expected that these already existing initiatives will still create effects on metrology until the last projects end in 2023. This is taken into account in the effectiveness assessment.

In parallel, the baseline situation means that the current implementation structure of the Article 185 initiative would be closed with the ending of EMPIR projects in 2023. This would involve winding down and social discontinuation costs. At the same time, there would be financial cost-savings related to the closing of the structure, as well as to operations, staff and coordination costs in particular. This is taken into account in the efficiency assessment.

Table 4: Key characteristics of the baseline situation - Horizon Europe calls

	What is feasible under this option - Functionalities of option
Type and composition of actors to be involved	<ul style="list-style-type: none"> - The wide scope of Horizon Europe calls would provide opportunities for NMIs and DIs to engage with a wide range of actors in specific sectors. Each NMI and DI would participate individually in calls under each of the six clusters. - Opportunities for engaging with cross-sectoral actors along the metrology value chain would depend on the scope of the future topics of a calls. - The broad nature, competitiveness, and large scale of Horizon Europe calls would make it likely that the larger, well-resourced NMIs would have the capacity to participate and smaller NMIs would lack the resources to engage.
Type and range of activities needed	<ul style="list-style-type: none"> - The broad scope of Horizon Europe calls would potentially allow metrology actors to contribute to a wide range of scientific activities. - The opportunities for metrology actors to engage with Horizon Europe calls would depend very much on the type of topics covered by the calls. The type and range of activities under Horizon Europe calls are intended to fulfil the needs of the Horizon Europe Strategic Plan. They would, therefore, be focussed on specific applications or scientific challenges, and not on challenges for the metrology community.
Priority-setting system and level of additionality required	<ul style="list-style-type: none"> - Horizon Europe calls would be focussed on cluster priorities (“expected impacts” decided under the Strategic Plan) and not on specific metrology priorities. Accordingly, the participation of NMIs and DIs would depend on the fit of call topics with their competences. In practice, this would be likely to lead to an uncoordinated approach to metrology funding that would not provide the necessary priority-setting system to achieve directionality, economies of scale and long-term sustainability. - Given that many NMIs and DIs would lack the financial capacity to participate in Horizon Europe calls, the effect of this option would, in practice, be the same for many NMIs and DIs as working alone at national level.
Coherence needed with external environments	<ul style="list-style-type: none"> - The Horizon Europe calls option would, by definition, ensure coherence with Horizon Europe. In practice, realising this coherence would depend on the extent to which NMIs and DIs would succeed in participating in Horizon Europe calls. - Given that Public-Private Partnerships under Article 187 TFEU have their own legal base outside the Framework Programme Rules for Participation, participation of NMIs and DIs in Horizon Europe calls would be unlikely to enhance coherence with them. - The pan-European focus of Horizon Europe calls would not dispose them to facilitating engagement of NMIs and DIs with national ministries and regional authorities at policy level beyond what could be achieved by NMIs and DIs alone at national level. - Horizon Europe calls, being broad and general in scope, would not be focussed on coherence with regulatory and standardisation frameworks and would not provide for engagement with regulators and standard-setters. - Horizon Europe calls would not be focussed on metrology topics and so would not facilitate coherence between metrology and wider policy environments on a systematic basis.

Key differences compared to the current situation	<ul style="list-style-type: none"> - Engagement of metrology in Horizon Europe would be based on participation of individual NMIs in calls under each of the six clusters of Pillar II⁸³. - The integrated engagement of the European NMIs and DIs in collaborative projects would not receive dedicated support. - Projects launched under the EMPIR initiative would continue, with European public funding of them until the final projects ending in 2023. - There would be financial costs of discontinuation of EUR 2-4 million and marginal savings, if any, in operational costs of launching traditional calls
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5.2 Description of the policy options

Table 4: Key characteristics of Option 1 – Co-Funded European Partnership

	What is feasible under this option - Functionalities of option
Type and composition of actors to be involved	<ul style="list-style-type: none"> - NMIs across Europe would be partners, so the actors would comprise metrology researchers. - The partnership would be closed with no channel for actors along the metrology value chain to join.
Type and range of activities needed	<ul style="list-style-type: none"> - Activities would be based on annual calls developed on a bottom-up basis without pre-agreed priorities. - There would be no top-down strategic or programming orientation.
Priority –setting system and level of additionality required	<ul style="list-style-type: none"> - The bottom-up nature and bi-annual basis of the topic-setting process for the call would support a short-term approach to priority-setting. - As the topics for the calls would be decided by the NMIs alone, the greater impact over what NMIs could achieve acting alone would be largely in cost savings by reduction of overlaps between NMIs. - As the partnership is focussed narrowly on the annual priorities of the NMIs and DIs, there is no additionality in terms of impact along the metrology value chain.
Coherence needed with external environments	<ul style="list-style-type: none"> - As the partnership would address the specific research needs of the NMIs, the scope for synergies with Horizon Europe would focus on specific aspects where metrology research is central. - The relevance of the partnership to national Ministries and regional authorities would be determined by the topics of the annual bottom-up calls - Given the close relationship between metrology and standardisation/regulation, the partnership would provide general coherence with ongoing regulatory and standardisation frameworks. The annual, bottom-up nature of calls would limit the scope to proactively enhance coherence with longer-term standardisation and regulatory frameworks or to engage with standard setters and regulators through the partnership. - The partnership would have the capacity to engage with global level metrology forums. Its scope for engaging in broader end-user and citizen-focussed frameworks would depend on the initiative of the NMIs and DIs.

⁸³ The interim evaluation of the EMPIR initiative made specific reference to the detrimental effect on the European metrology system when dedicated funding to it was removed under the Fifth Framework Programme.

Table 5: Key characteristics of Option 2 – Institutionalised European Partnership (Article 185 TFEU)

Article 185 Initiative: Definition and Criteria	
<p>An Article 185 Initiative is a long-term public-public partnership established by Member States. It is eligible for a substantial financial contribution from the European Framework Programme.</p> <p>An Article 185 Initiative aims at addressing common challenges in a specific research area by creating economies of scale and synergies between national and EU research programmes and investments. The goal is to achieve scientific, managerial and financial integration amongst national research programmes in a given field.</p> <p>The following criteria are the basis for the establishment of an initiative under Article 185:</p> <ul style="list-style-type: none"> - relevance to objectives of the Member States - existing or envisaged research programmes or national/regional budgets that can be committed 	
<ul style="list-style-type: none"> - European added value - critical mass - efficiency of Article 185 as the most appropriate means - three levels of integration: scientific, management and financial - application of the Rules for Participation of the European Framework Programme 	

What is feasible under this option - Functionalities of option	
Type and composition of actors to be involved	<ul style="list-style-type: none"> - The core actors would be the NMIs and DIs. - Actors in the wider metrology value chain including national ministries, standards setters, regulators, industry, end-users and consumers would be involved in programme development and in implementation via the networks (EMNs). This involvement of private sector actors would allow them to have strategic influence in the initiative, so inventivising their involvement. - A Steering Group would provide policy-level guidance to the initiative and so facilitate such a more programmatic approach. This Steering Group should be above the implementation level of the initiative. It would be composed of policy-level representatives of national ministries (rather than representatives with budget-level responsibility for metrology), representatives of standard-setters and regulators, as well as end-users including industry and societal interests. Industry could be represented by public-private partnerships under Horizon Europe, thus ensuring a basis for co-operation and communication between the metrology initiative and these partnerships. - Research actors, public and private, who are not a part of a NMI or DI, would participate as partners of the consortia in the funded research projects.
Type and range of activities needed	<ul style="list-style-type: none"> - Activities would include top-down programming of the initiative, based on stable, long-term investment commitments and strategic implementation of the programme at project level via dedicated networks.
Priority –setting system and level of additionality required	<ul style="list-style-type: none"> - The Steering Group would provide advice to the initiative on how its research priorities can best be aligned with the needs of stakeholders all along the metrology value chain, including end-users. - Top-down steering would ensure a programmatic approach to implementation of the initiative in a way that individual NMIs and DIs could achieve on their own or through ad hoc project-level collaboration. - The national institutionalised funding available for NMIs/DIs would be compatible with this instrument to the full extent, and can be used as the national contribution to the initiative.

Coherence needed with external environments

- Top-down steering of the initiative would facilitate the realisation of synergies with Horizon Europe.
- Implementation of the initiative via EMNs that focus on emerging technologies and societal challenges would make the initiative relevant for public-private partnerships in areas such as ICT, manufacturing, energy, climate and health. This could pave the way for the organisation of cross-cutting calls. Take health, for example, where metrology is important in ensuring accurate measurements in health diagnostics and delivery; so synergies could be explored with the Innovative Health Initiative and the Partnership for Large-scale innovation and transformation of health systems in a digital and ageing society.
- The involvement of national Ministries in the steering of the initiative would enhance its relevance for policy-making and so facilitate synergies with national and regional programmes.
- The involvement of regulators and standardisation bodies in the programming of the initiative would allow it to develop a proactive focus on emerging regulatory and standardisation needs, in addition to contributing to ongoing regulatory and standardisation issues.
- By bringing together NMIs and Dis across Europe, the initiative would have the capacity to engage in global-level metrology forums. Moreover, the broader engagement of actors along the wider metrology value chain would give it the necessary breadth to be coherent with the needs of citizens for confidence in the robustness of measurement systems in their daily lives.

5.3 Options discarded at an early stage

The Co-Programmed Partnership and an Institutionalised Partnership created under Article 187 of the TFEU are not considered as relevant options because such models focus primarily on public-private partnerships with industry as a partner taking long term commitments. No stakeholder groups would support such solutions⁸⁴, since the primary responsibility and the essential commitment from the national metrology and designated institutes would not materialise. The lack of public commitment would render the implementation impossible.

6. HOW DO THE DIFFERENT POLICY OPTIONS COMPARE TO ACHIEVE THE EXPECTED IMPACTS?

Based on the objectives pursued by the initiative and the key functionalities identified to be able to achieve them, each option for implementation is assessed in terms of effectiveness, efficiency and coherence compared to the baseline scenario of traditional calls. The analysis is based primarily on the degree to which the different options would cater for the key functionalities required. All options are compared to the baseline scenario of traditional calls, which is thus consistently scored at 0 to serve as reference point.

6.1. Effectiveness

To be in line with the Horizon Europe impact framework, the fulfilment of the specific objectives of the initiative is translated into ‘expected impacts’ (what success would look like), differentiating between scientific, economic/ technological, and societal (including environmental) impacts. This section considers the extent to which the different policy options would enable these expected impacts to be delivered – confronting what is needed (functionalities) with what each form of implementation can provide in practice.

⁸⁴ Both from position papers from the Member States as well as from the public consultation.

6.1.1. Scientific impacts

Metrology is by nature a cross-sectoral research area; thus the impact is expected to come across various sectors. In this regard, the key scientific impact factors are: realising a sustainable and efficient integrated European metrology system beyond 2030; improving awareness and understanding of the metrology system across the innovation and policy-making systems; and ensuring Europe is a world-leader in metrology capabilities.

Under **the baseline option**, metrology, as a cross-sectoral discipline, would be relevant across all six clusters of Pillar II of Horizon Europe. As a consequence, metrology would not be the specific focus of any cluster and with the risk that, given wide scope of clusters, it would lose out to dedicated cluster priorities. Cross-cluster calls could serve as the entry point for research in metrology but support for metrology would then be widely spread, reinforcing the current fragmented approach to supporting of metrology research. Moreover, the likelihood is that only large NMIs would have the resources to participate in Horizon Europe calls. Accordingly, there is a significant risk of disengagement of the metrology community from European research, leading to loss of the scientific impact achieved under the Seventh Framework Programme and Horizon 2020.

Compared to the baseline, Option 1 would facilitate pooling of resources by NMIs, resulting in calls focused on metrology as a stand-alone scientific discipline. The nature of calls would be annual and bottom-up, based essentially on national funding priorities and therefore lead to a “scattergun approach” to funding, resulting in a significant reduction in scientific impact. A co-funded partnership would only involve NMIs, leaving universities without a role. That would ensure an increased focus on NMIs’ priorities but at the same time poses a great risk of evolving to a “closed club” discouraging academia from engaging, therefore not remedying the shortcomings identified in the mid-term evaluation. In general, this options is ensuring higher value-added of EU contribution to funding than what would be achieved by NMIs pooling funds on their own. This option would thus be scored (0), i.e. equal compared to the baseline on the sustainable and integrated European metrology system, (0) on improved awareness and (+) on Europe’s world-leading role.

Option 2 provides for a programmatic approach involving a Steering Group. This would facilitate co-created programming of funding towards specific priorities ensuring ownership of all stakeholders in the metrology value chain. This option gives the possibility of long-term focusing on specific scientific challenges, and a cross-disciplinary approach via metrology networks, reinforcing the expected scientific impact. This approach would respond to the recommendation of the mid-term evaluation to strengthen the strategic component and thus maximise the added-value of EU funding to metrology. This option would thus be scored (++) compared to the baseline on the sustainable and integrated European metrology system, (++) on improved awareness and (++) on Europe’s world-leading role.

Summary

Table 6, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 6 - Overview of the options' potential for reaching the scientific impacts

	Option 0 Horizon Europe calls	Option 1 Co-funded	Option 2 Institutionalised Art. 185
Integrated European Metrology System beyond 2030	0	0	++
Improved engagement with and participation in the metrology system across the innovation and policy-making systems by 2030	0	0	++
Europe provides metrology solutions by 2030 at least equal to the top global performers	0	+	++

Notes: Score ++: Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline

6.1.2. Economic/Technological impacts

The key economic/technological impact factors for metrology are: growth of innovative businesses selling or using measurement equipment; and development of new innovative products and services that contribute to sustainable economic growth.

Under **the baseline option**, metrology research would depend on individual NMIs being willing to invest resources to prepare proposals and on other stakeholders in Horizon Europe being open to collaboration. The ad hoc nature of projects under this option would limit the possibilities for a coordinated approach with economic and technological stakeholders, thus failing to address the recommendation of the mid-term evaluation to engage with other communities. Moreover, there would be no incentive for the metrology researcher to engage with stakeholders along the metrology value chain. The absence of a programmatic approach leads to the risk of metrology research being excluded and the economic and technological impacts achieved impacts to date being lost.

Compared to the baseline, Option 1 would ensure focused investment in metrology and critical mass of funding to address economic/technological impacts. However, funding arrangements under this option would limit incentives for the partnership to extend research beyond the scientific dimension to address economic/technological impacts. This option would fail to respond to the recommendation of the mid-term evaluation to develop centres of excellence in form of networks with downstream stakeholders. Equally, the lack of direct engagement of economic and technological stakeholders would limit the wider impact. This option would thus be scored (0) compared to the baseline on sales leading to growth of measurement businesses, and (+) on sales leading to sustainable growth overall.

Option 2 would ensure focused investment in metrology and thus create momentum towards a critical mass of funding to address economic and technological impacts. The Steering Group would provide the pro-active longer-term approach to research programming necessary to achieve economic and technological impacts, facilitating the involvement of private sector actors and incentivising their participation. Implementation of research via technological challenge-driven networks would help deliver economic and technological impacts more effectively as recommended by the mid-term evaluation. This option would thus be scored (++) compared to the baseline on sales leading to growth of measurement businesses, and (++) on sales leading to sustainable growth overall.

Stakeholder opinion

Most stakeholders interviewed agreed that economic impact would be greater within models that supported the involvement of stakeholders outside the typical NMI/DI community. In addition, respondents agreed that this would have an impact on supporting more innovative technology based business and increasing employment within these business, and providing higher added-value innovative products.

Summary

Table 7, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 7 - Overview of the options' potential for reaching the likely economic/technological impacts

	Option 0 Horizon Europe calls	Option 1 Co-funded	Option 2 Institutionalised Art. 185
Sales in 2030 of innovative products and services due to metrology programme and project outcomes (leading to growth of innovative businesses that sell and/or use measurement equipment)	0	0	++
Sales in 2030 of innovative products and services due to metrology programme and project outcomes (leading to new innovative products that contribute to sustainable economic growth)	0	+	++

Notes: Score ++: Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline

6.1.3. Societal impacts (including environmental, social, fundamental rights and engagement with stakeholders)

The key societal impact factor for metrology is the contribution to evidence-based policy making, assessment, and implementation of current and future European regulations and policy as well as the standards that underpin them.

Broad collaboration between researchers, regulators, standards setters and wider policy stakeholders is needed for metrology efforts to deliver societal impact. **The baseline option**, given the broad nature of the clusters under Horizon Europe, would allow metrology to make some contribution to societal impact but this would be sub-optimal due to the likely ad hoc, non-systematic participation of metrology stakeholders in calls. Metrology stakeholders would have little influence over the calls in which they would participate because this would depend on whether the scope of the calls included a metrology dimension. As result, there would be no incentive for NMIs to proactively develop new collaborations with downstream societal stakeholders. Accordingly, the specialised, technical nature of metrology would limit its scope to contribute to delivering societal impacts via Horizon Europe calls. Hence, its effectiveness would increasingly be challenged.

Compared to the baseline, Option 1, being limited to a partnership among the NMIs that opt in, would tend to limit the societal impacts of metrology. There would be no structured participation of societal stakeholders in the partnership and no incentive for NMIs to widen the scope of the partnership to deliver societal impacts. Previous partnerships have demonstrated that metrology can play a significant role in terms of societal impacts in relation to, for example, the environment, health and energy. Under this option, however, any societal impact is likely to be a by-product of research rather than a strategic outcome. As such, any societal impact is unlikely to be sustained. Accordingly, the narrow and limited participation in the partnership can actually hinder delivering societal impact. This option would thus be scored (+) compared to the baseline on metrology contributions to regulations and policy.

Under **Option 2**, the up-front, long-term, commitment to specific objectives, coupled with ongoing monitoring of performance against key success factors, would create a continuing focus on delivering societal impact. For example, networks could be required to include a KPI covering contributions to relevant UN Sustainable Development Goals. Moreover, implementation through specialised networks that are open to all relevant stakeholders would ensure that societal priorities are embedded in the implementation of the initiative. A key success factor under this option would be securing the participation and contributions of a broad base of stakeholders to future work programmes, including representatives of relevant public-private partnerships as well as actors along the metrology value chain. Moreover, the strategic, programming approach under this option would create momentum towards wide engagement with stakeholders. Workshops could be organised to secure the input of stakeholders to work programmes, which should be co-created with them. Accordingly, the broad base and top-down guidance underpinning the partnership enhances the capacity and scope for addressing societal impact. This option would thus be scored (++) compared to the baseline on metrology contributions to regulations and policy.

None of the above options is expected to impact fundamental rights in the EU or abroad.

Stakeholder opinion

The majority of respondents to the open consultation agreed that a specific legal structure (funding body) with robust governance is necessary or very necessary to making the changes in the metrology system happen, to support better links to regulators and harmonisation of standards.

Summary

Table 8, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 8 - Overview of the options' potential for reaching the likely societal impacts

	Option 0 Horizon Europe calls	Option 1 Co-funded	Option 2 Institutionalised Art. 185
Metrology contributes widely to European regulations and policy and the standards that underpin them by 2030	0	+	++

Notes: Score ++: Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline

6.2. Efficiency

In order to compare the policy options under common standards consistently in terms of their efficiency, a standard cost model was developed for the external study supporting the impact assessment for the set of candidate Institutionalised Partnerships. The model and the underlying assumptions and analyses are set out in the Common Part of this impact assessment, Section 2.3.2 and in the Methodology Annex 4. A dedicated Annex 3 also provides more information on who is affected and how by this specific initiative in line with the Better Regulation framework. The scores related to the costs set out in this context allow for a “value for money” analysis (cost-effectiveness) in the final scorecard analysis in Section 6.4.

In addition, for this specific initiative under the **baseline** scenario of traditional calls, there would be winding down costs for the existing implementation structure of the current Article 185 initiative. The winding down costs would also include the costs of transferring competences and activities from the current structure to new structures under EURAMET to maintain the current capacity and knowledge transfer that the members would like to maintain. Depending on the choices made, these can be estimated at EUR 2-4 million. There would also be longer term financial cost-savings related to the closing of the structure, related to operations, staff and coordination costs in particular. These can be estimated at EUR 3 million per year of operation⁸⁵. Overall it is estimated that the overall long-term cost savings from using traditional calls instead of an existing Article 185 initiative would not significantly exceed the costs incurred for winding down operations⁸⁶. This overall situation is set as the starting point for the comparison of options. The score of this baseline scenario (traditional Horizon Europe calls) is set to 0 to be used as a reference point.

On this basis, the scores for the costs of the different options range from a value of 0, in case an option does not entail any additional costs compared to the baseline, to a score of (-) when an option introduces limited additional costs when compared to the baseline and a score of (--) when substantial additional costs are expected in comparison with the baseline. In case the costs are lower than for the baseline scenario, scores of (+) and (++) are used.

It is considered that while there is a clear gradation in the overall costs of the policy options, the cost differentials are less marked when one takes into account the expected co-financing rates and the total budget available for each of the policy options, assuming a common Union contribution. From this perspective, there are only one or two percentage points that split the most cost-efficient policy options – the baseline (traditional calls) and the **Co-Funded** policy options – and the least cost-efficient – the **Institutionalised** Partnership options. Indeed, in terms of cost-efficiency, the Co-funded Partnership is 2 percentage points more cost-efficient than the baseline; while an Article 185 Institutionalised Partnership is as cost-efficient as the baseline. A score of (+) is therefore assigned for cost-efficiency to the Co-Funded option and a score of (0) for the Article 185 Institutionalised Partnership policy option.

Looking at cost-efficiency on the broader perspective of attracting higher level of commitments from Participating States and industrial leverage, the Institutionalised

⁸⁵ This is based on the financial estimates of the current initiative EMPIR, and includes Commission supervision.

⁸⁶ As explained in annex 4 once the co-funding contributions are taken into account

Partnership option appears to be much more cost-efficient. The reason is a much higher total investment in the research activities by leveraging the national resources and a much higher contribution from the private actors by clear buy-ins to fit for purpose metrology infrastructures and capabilities.

In the case of the current EMPIR initiative, the assessment of the contributions can be considered as an indication of the leverage achieved by EU funds and is clearly a strong sign that EMPIR has managed to attract both national funding for metrology and shown industrial leverage. For the period up until the mid-term review, it was established that more than half of the Participating States’ research funding was channelled through the initiative, and by September 2019 more than EUR 350 million could be directly linked to increased industrial turnover from new products and services from the Article 185 initiatives.

It should be noted that the potential for the creation of crowding-in effects for industry has been taken into account when assessing the effectiveness of the policy options.

Financial management of the existing metrology initiative EMPIR, as stated in its mid-term evaluation, appears to be robust and the views of the public and beneficiaries sought in the consultations are strongly positive. The administrative costs of the current initiative, funded by the Participating States, is constantly below 5% of the total costs and was in 2019 estimated to 3.9% of the call budget (total costs) of the same year. The summary of the scores is listed in Table 9. It should be noted that the overall costs refer to the ratio of administration costs over the total budget of funding, while the adjusted (cost-efficiency) figure takes into account the co-funding rates of the different policy options and applies them to the same ratio. This is further developed in section 2.3.2 of the common part.

Table 9 - Matrix on ‘overall costs’ and ‘adjusted cost scoring’

	Baseline: Horizon Europe calls	Option 1: Co-funded	Option 2: Institutionalised Article 185 TFEU
Administrative, operational and coordination costs	0	(-)	(--)
Administrative, operational and coordination costs adjusted per expected co-funding (i.e. cost-efficiency)	0	(+)	0

Notes: Score 0 = same costs as for the baseline; score (-) = limited additional costs compared with the baseline; score (-) = substantial additional costs compared with the baseline.

Stakeholder opinion

Several stakeholders mainly representing academic/research institutions and to a less degree companies/ business organisations or public authorities considered an institutionalised partnership as the most efficient option for an initiative in metrology.

6.3. Coherence

6.3.1. Internal coherence

This section assesses the extent to which the options offer the potential to ensure and maximise coherence with other actions, programmes and initiatives under Horizon Europe and, notably, partnerships.

Under the **baseline option, with traditional calls under the Framework Programme**, coherence can be ensured between the activities under the clusters and metrology. However, exploitation of synergies between metrology and other initiatives, including exchanges of knowledge and experience between project teams and stakeholders, would require an additional level of coordination between and beyond Programme Committees. This is due to the national integration of metrology capacity which is not always fully represented in the current comitology processes for research and innovation, and due to the broader remit of the Programme Committees compared to earlier Framework Programmes. Therefore, while fundamental research activities could be managed under the baseline option, traditional calls are sub-optimal to address coordination and closer collaboration between research, industry and decision-makers to define cohesive programmes.

Option 1, the co-funded partnership, would achieve internal coherence among the NMIs. However, there will be a lack of coherence beyond the project consortia, since the partnership will be focussed to the funding of project activities. This will hinder the establishment of a long-term framework with a vision beyond each project and beyond the duration of the partnership. As a consequence, this outcome will limit the long-term commitments of the partners, thus while coherence among the NMIs will be enhanced, the full potential of achieving coherence with other stakeholders in Horizon Europe, including other partnerships, would not be made possible. This option would thus be scored (+) compared to the baseline.

In **option 2, institutionalised partnership under Article 185 TFEU**, the structure would provide roles for the NMIs and the Commission which would facilitate coherence with Horizon Europe. This structure would be able to interact with any Programme Committee configuration with the correct stakeholders for long-term strategic implementations. In addition, all NMIs would have the opportunity to participate, whether formally Participating States or not. In addition, an institutionalised partnership would enable the Steering Group to fulfil a programmatic coordination function that would increase the coherence with Horizon Europe and affiliated stakeholders, such as and in particular other partnerships. In conclusion, internal coherence would be optimised because the structure would bring together the NMIs, the Commission and other relevant stakeholders in a way that would facilitate objective-setting, roadmap development and project implementation. This option would thus be scored (++) compared to the baseline.

Stakeholder opinion

Respondents to the open consultation noted that a partnership based on Article 185 is relevant or very relevant for supporting more buy-in and long-term commitment from other partners. Furthermore, it was underlined that the selected option should provide a clear and coherent mechanism for supporting the widest possible engagement with stakeholders as the centralised coordination and management would provide oversight required for coordinated engagement outside the NMI/DI community.

6.3.2. External coherence

This section assesses the extent to which the policy options offer the potential to ensure and maximise coherence with their external environment, including EU-level programmes and initiatives beyond the Framework Programme, regional, national and international programmes and initiatives, as well as with overarching framework conditions, such as regulation and standardisation.

The **baseline option**, calls under Horizon Europe, the rules for participation would facilitate some coordination with other European programmes and activities in terms of joint priority setting. However, the coordination will depend on the capacity of individual NMIs to engage with these activities. On a national and regional level, the coordination with other programmes will be more difficult due to the division between European and national competences and the perceived risk of double funding. Coherence with relevant regulatory and standardisation frameworks would vary between thematic areas and, given the supply-side orientation of the Framework Programme, the coherence would be on an ad hoc basis and risk to be not enhanced overall. Finally, given the general European focus on the traditional calls, there is a large likelihood that the programming would hinder the engagement of metrology in wider international agreements and organisations, which is crucial for any metrology system.

The narrow stakeholder base of a **co-funded partnership** would make it difficult to find areas of mutual relevance with other European programmes. But since the NMIs would be in focus as central partners, a co-funded partnership would facilitate coordination with national programmes in metrology. Conversely, the specific research focus of a partnership co-funded with NMIs would hinder cohesion with wider programmes at national level that would potentially benefit from further interactions with the core metrology community. The close connections between NMIs and regulators and standards setters would facilitate strong relations. However, the bottom-up nature of a co-funded partnership means that projects funded would not necessarily address areas of importance for regulation and standardisation so greater cohesion would not be ensured, and would only happen on an ad hoc level. Cohesion with international metrology agreements and organisations would be enhanced by the common membership of many NMIs and of EURAMET at European level. This option would thus be scored (0).

The broad involvement of stakeholders along the metrology value chain would, in an **institutionalised partnership**, facilitate coherence with other European programmes, and notably those for which metrology research is a significant input. Coordination with national and regional programmes would be enhanced through the Steering Group and the overall governance structure of the initiative, and in particular for activities linked to Smart Specialisation. This would help focus metrology research sufficiently widely to engage stakeholders in these programmes. The engagement of regulators and standards-setters as stakeholders in the strategic programming of the initiative would steer metrology priorities in a direction that supports new regulations and standard setting and enhance coherence. By engaging the full breadth of stakeholders in the activities of the partnership, and within the metrology networks, would facilitate engagement with relevant international agreements and organisations. This option would thus be scored (++) compared to the baseline.

Stakeholder opinion

A number of stakeholders interviewed and responding to the open consultation indicated potential links in relation to key application areas, e.g. key digital technologies or smart networks. The majority of stakeholders interviewed and around half of those responding to the open consultation also highlighted that metrology is a horizontal activity and therefore should retain centralised coordination and connection across Europe. The majority of respondents to the open consultation agreed that establishing a specific legal structure was relevant or very relevant to facilitating synergies with EU/national programmes and facilitating collaboration with other partnerships.

Summary

Table 10, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 10 - Overview of the options' potential for ensuring and maximising coherence

	Option 0 Horizon Europe calls	Option 1 Co-funded	Option 2 Institutionalised Art. 185
Internal coherence	0	+	++
External coherence	0	0	++

Notes: Score ++: Option presenting a *high* potential compared to baseline; Score +: Option presenting a *good* potential compared to baseline; Score 0: Potential of the baseline

6.4. Tabular comparison of options and identification of preferred option

Building upon the outcomes of the analysis, this section presents a comparison of the options' performance against the dimensions of effectiveness, efficiency and coherence.

Table 11 - Overall scorecard of the policy options for all options

	Criteria	Option 0 Horizon Europe calls	Option 1 Co-funded	Option 2 Institutionalised Art. 185
Effectiveness	Scientific impacts			
	Integrated European metrology system beyond 2030	0	0	++
	Improved engagement with and participation in the metrology system across the innovation and policy-making systems by 2030	0	0	++
	Europe provides metrology solutions by 2030 at least equal to the top global performers	0	+	++
	Economic/technological impacts			
	Sales in 2030 of innovative products and services due to metrology programme and project outcomes (leading to growth of innovative businesses that sell and/or use measurement equipment)	0	+	++
	Sales in 2030 of innovative products and services due to metrology programme and project outcomes (leading to new innovative products that contribute to sustainable economic growth)	0	+	++
	Societal impacts			

	Criteria	Option 0 Horizon Europe calls	Option 1 Co-funded	Option 2 Institutionalised Art. 185
	Metrology contributes widely to European regulations and policy and the standards that underpin them by 2030	0	+	++
Coherence	Internal coherence	0	+	++
	External coherence	0	0	++
Efficiency	Overall cost	0	-	--
	Cost-efficiency	0	+	0

Notes: Scores for effectiveness and coherence: ++ = *substantially higher performance*; + = *higher performance*; - = *lower performance*. As compared to the baseline, the scores for the costs and cost efficiency of the different options range from a value of 0, in case an option does not entail any additional costs to a score of (-) when an option introduces limited additional costs when compared to the baseline and a score of (--) when substantial additional costs are expected in comparison with the baseline. In case the scores are lower than for the baseline scenario, (+) and (++) are used.

Overall, support for metrology through an institutional partnership under Article 185 TFEU is the preferred option. This form of partnership would provide a stable framework that would ensure the commitment of the partners to long-term objectives. It would also provide the basis for a strategic approach to the future development of metrology in Europe and would, in this regard, be sufficiently flexible to allow top-down guidance from a steering group and targeted implementation of the initiative through specialised networks.

By facilitating a long-term strategic approach and targeted implementation, this form of partnership would attract increased commitment and participation from industry and other end-users, leading to the take-up of metrology solutions. The incentive for private actors to engage in the partnership is twofold. First, is the opportunity to participate directly in research projects under the same conditions as Horizon Europe, for which they are directly funded for their research activities as in Horizon Europe. Secondly, by participating in the Steering group, it allows interaction at an early stage with regards to the priorities setting for metrology development. This would allow private actors to have the necessary access for early uptake of metrology solutions, thus obtaining a competitive advantage. This strategic approach and targeted implementation, together with increased participation of industry and other end-users, would provide the path to a metrology system with much stronger capabilities and a top performer at global level.

Table 12 - Comparison between the preferred option & the current partnership existing in the area taking into account lessons from past evaluations

What continues	What is different
<ul style="list-style-type: none"> • Long-term financial commitments of partners in line with requirements of Article 185 TFEU • Direct engagement with national metrology systems through participation of NMIs/DIs 	<ul style="list-style-type: none"> • Top-down strategic approach to programming facilitated by Steering Group, including national ministries and industries represented in public private partnerships • Increased incentive for input from non-partner stakeholders including standards-setters, regulators, industry and other end-users as well as wider research actors • Deepening of integration through implementation of strategic priorities by top-down, targeted, pan-European metrology

<ul style="list-style-type: none"> • Pan-European, dedicated implementation structure 	<p>networks</p> <ul style="list-style-type: none"> • Closer alignment with other initiatives under Horizon Europe, and notably public-private partnerships, through explicit engagement of relevant PPPs in Steering Group • Exit strategy based on pan-European networks providing metrology solutions by 2030 at least equal to the top global performers with implementation via dedicated European Metrology Networks
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As Table 12 summarises, the partnership would be established under Article 185 TFEU with a dedicated implementation structure. Compared to previous partnerships, the metrology initiative would be more strategic, with involvement of national ministries and of a wider range of non-partner stakeholders, as well as closer alignment with other initiatives under Horizon Europe. Implementation would also be novel, involving dedicated networks⁸⁷.

Role of Steering Group in European Metrology Initiative

To support the more strategic approach envisaged for the initiative, a Steering Group would be set up. The Steering Group would focus on the longer-term policy impact of the initiative from a broader European perspective. It would, therefore, be above the implementation level of the initiative and would not act as a governing board.

The role of the Steering Group would be to provide strategic guidance to the initiative for the programming of its activities. It would inject new ideas to guide the initiative in anticipating metrology needs to support early adoption of emerging technologies and address societal challenges.

To facilitate its guidance role, the Steering Group would be convened by the European Commission and would involve relevant national ministries at policy level related to emerging technologies and societal challenges (as distinct from national ministries with budgetary responsibility for metrology). It would also include key stakeholders along the metrology value chain including standards-setters and regulators as well as end-users including industry, user groups and citizen representatives.

In this way, industry and other private stakeholders would be involved in the conception and strategic steering of the initiative. This would facilitate orientation of the initiative in line with the priorities of industry and other private players along the metrology value chain. In this way, there will be significant incentive for these players to commit to and participate in the initiative on a long-term basis.

The Steering Group would also facilitate interaction with European public-private partnerships under Horizon Europe, which would play a key role in identifying new innovations in global competitor regions where metrology can support European leadership in global markets.

⁸⁷ There are networks being piloted by EURAMET at the moment, which have the potential to participate in a future initiative. These are Quantum technologies, Laboratory medicine, Smart electricity grids, Energy gases, Climate and Ocean observation, and Mathematics. In addition, there are proposed networks also in Advanced Manufacturing, Biotechnology for Health, Food Safety, Environmental Monitoring, Radiation Protection, Digitalisation, and Clean Energy.

This impact assessment has been prepared while negotiations on the next Multiannual Financial Framework are ongoing. Any future metrology initiative would depend on the necessary budget being available once the Multiannual Framework Programme has been adopted and financial provision been made for Horizon Europe, the prospective European Framework Programme 2021-2027. In this regard, a future initiative would also depend on possible modifications to the budgetary allocation to contribute to the European response to the COVID-19 pandemic.

In parallel to the budgetary negotiations, discussions are ongoing with the core stakeholders in a potential future metrology initiative on a Strategic Research and Innovation Agenda. At national level, stakeholders include the NMIs and DIs as well as the ministries with responsibility for metrology. At European level, the main stakeholder is EURAMET, the European Association of National Metrology Institutes.

Stakeholder opinion

The initiative in metrology received 225 responses in the public consultation that was launched in September 2019. The major groups were representatives of academic/research institutions, company/business organisations, EU citizens and public authorities. All four group separately indicated the institutionalised partnership as their preferred option for addressing metrology needs, by a percentage that varied between 62-77% (see Annex 2).

7. THE PREFERRED OPTION - HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

7.1. The preferred option

In *Table 13* below, the alignment of the preferred option with the selection criteria for European Partnerships defined in Annex III of the Horizon Europe Regulation is indicated. Seeing that the design process of the candidate Institutionalised Partnerships is not yet concluded and several of the related topics are still under discussion at the time of writing, the criteria of additionality/directionality and long-term commitment are covered in terms of expectations rather than ex-ante demonstration.

Table 13 - Alignment with the selection criteria for European Partnerships

Criterion	Alignment of the preferred option
Higher level of effectiveness	In an Article 185 partnership, the specific objectives would be more reached more effectively. In particular, it would ensure the widest possible group of stakeholders across the value-chain to not only conduct a programme of strategic collaborative research, but to also create sustainable European Metrology Networks for cooperation and coordination of metrology R&I. The institutionalised partnership would be most the most effective option to ensure an ‘exit strategy’ that avoids a cliff-edge at the end of the partnership.
Coherence and synergies	As demonstrated in chapter 6, the preferred option would include a secretariat and a management support unit that would ensure that the metrology research strategies are integrated in the European Research Area, and to concurrently running partnerships. All partnerships under Horizon Europe would be relevant, and in particular initiatives under Cluster 4, 5, and 6. The preferred option provides a visible central focus for metrology R&I in Europe as well application specific networks to act as access points between the stakeholder community and, moreover, it provides a focal point for interactions between metrology institutes with European policy-makers addressing the Green Deal, the Energy Union and Strategy, Environment Policy

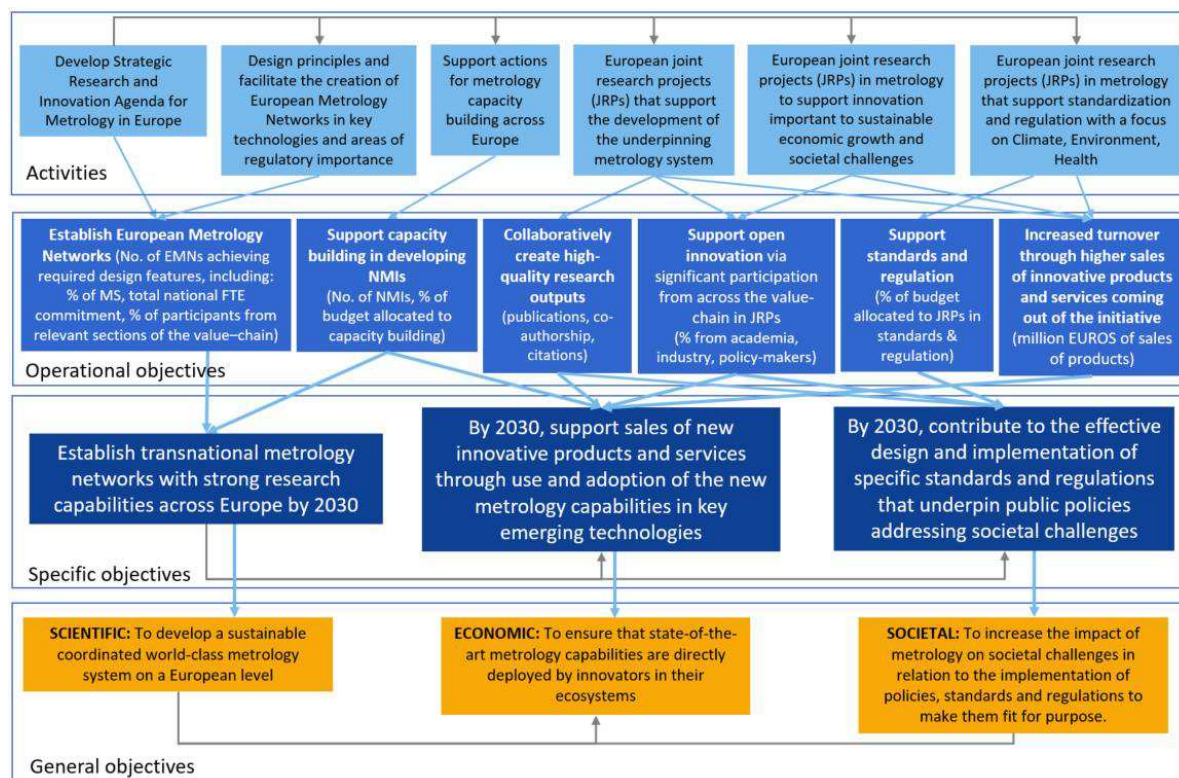
	and Public Health.
Transparency and openness	<p>The preferred option, as discussed earlier chapters, will maximise its transparency by involving relevant stakeholders along the value-chain - from NMI/DIs and academia to industry and policy-makers and regulators. Research actors outside the metrology community would have, through the structure of the partnership, direct support for liaising with the metrology community and joining collaborative research projects.</p> <p>The institutionalised partnership would furthermore help community building around key strategic areas for metrology, and ensure transparent uptake through the metrology value chains. The institutionalised partnership would also use the Horizon Europe rules for participation, which would also ensure transparency in the proposal and project participations.</p>
Additionality and directionality	<p>An Article 185 institutionalised partnership would be able to make a long-term policy and financial commitment to the partnership, committing funds of a minimum of 50% of the total budget including a cash contribution to support its management.</p> <p>An institutionalised partnership would also, via the implementing body, act with a high degree of strategic directionality, working at a European level and above and beyond national interests, and to adjust to changing policy, societal and market needs. Where metrology is concerned there is considerable motivation to work together as no one country can manage the increasing demands on the metrology system and therefore commitment to utilise the governance structure of the Article 185 partnership to make this happen.</p>
Long-term commitment	The expectation is that the majority of Member States will participate (greater than the number in the Horizon 2020 partnership) with a commitment of at least 50% matching funding from Member State in accordance with article 185 TFEU.

7.2. Objectives and corresponding monitoring indicators

7.2.1. Operational objectives

The links between operational objectives with suggested monitoring indicators and the activities and the specific objectives are detailed in Figure 9.

Figure 9 - Relationship between the activities and the objectives



7.2.2. Monitoring indicators

In addition to Key Impact Pathways indicators set centrally in the Regulation of Horizon Europe, additional monitoring indicators have been identified to enable the tracking of progress of the partnership towards meeting its objectives. These are shown in Table 14.

Table 14 - Monitoring indicators in addition to the Horizon Europe key impact pathway indicators

	Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
Scientific impact			
<i>Scientific progress through the development of research excellence in European Metrology Networks</i>	<p>Establish at least a number of networks driving partnership research activities</p> <p>Across all Networks: In % of Networks' advisory /steering groups from measurement users</p>	Leveraged R&I funding driven by / aligned with network remit.	<p>Increased participation by non-NMI/DI stakeholders in:</p> <ul style="list-style-type: none"> In % of Networks' overall project activities In % of Networks' membership and governance structures
<i>Scientific impact of overall research excellence in metrology</i>	<p>In % of research participants from academia and in euros of funding allocated to them (see also indicators under technological /economic impact)</p> <p>Number of publications</p>	<p>No. of citations compared to international norms in the fields</p> <p>No. of patents</p>	<p>Europe a world-leading in metrology, as evidence by leadership roles in international metrology</p> <p>Research collaborations and co-authored publications leading NMIs/DIs outside Europe (USA, Japan, China,</p>

			etc.)
Economic / technological impact			
<i>Sales of innovative products and services due to metrology programmes and projects findings (leading to growth of innovative businesses that sell or use measurement equipment and to innovative products available to contribute to sustainable economic growth)</i>	In % of research participants from industry In EUR in co-funding of research	Above EUR 50 million annually of sales of innovative products whose development is attributable (fully or in part) to new or enhanced metrology capabilities	Growth in EUR among the innovative businesses that have engaged with the partnership
Societal impact			
<i>Metrology research and innovation contributions to European regulations and policy and the standards that underpin them</i>	In % of research budget allocated to normative research (& relevant support for impact projects?)	No. of contributions to specific standards that underpin policy / regulation in climate, environment and health	Assessment and engagement of the policy-making/ regulation community as to the value of the metrology contributions

7.2.3. Evaluation framework

The evaluation of the partnership will be done in full accordance with the provisions laid out in Horizon Europe Regulation Article 47 and Annex III, with external interim and ex-post evaluations feeding into the overall Horizon Europe evaluations. As set in the criteria for European Partnerships, the evaluations will include an assessment of the most effective policy intervention mode for any future action; and the positioning of any possible renewal of the partnership in the overall European Partnerships landscape and its policy priorities. In the absence of renewal, appropriate measures will be developed to ensure phasing-out of Framework Programme funding according to conditions and timeline agreed ex-ante with the legally committed partners.