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This document was developed by the EURAMET e.V.

Authors: Jörn Stenger (PTB, Germany), Maguelonne Chambon (EURAMET Vice-Chairperson (Research), LNE, France), Miruna Dobre (EURAMET Vice-Chairperson (GA), SMD, Belgium) Hans Arne Frøystein (EURAMET Board of Directors Member, JV, Norway), Robert Gunn (Chair of EURAMET's Technical Committee for Interdisciplinary Metrology, NPL, United Kingdom), Maros Kamensky (SMU, Slovakia), Dolores del Campo (EURAMET Chairperson, CEM, Spain), Anne Trumpfheller (EURAMET Communications Officer), Mikko Merimaa (EURAMET General Secretary).

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EURAMET e.V.  
Bundesallee 100  
D-38116 Braunschweig  
Germany

E-Mail: [secretariat@euramet.org](mailto:secretariat@euramet.org)

Phone: +49 531 592 1960

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## Further information

For further information about this document, please contact the EURAMET Secretariat ([secretariat@euramet.org](mailto:secretariat@euramet.org)).



## Metrology for a stronger Europe

### A European Metrology Agenda for the next decade

#### Summary

The EU's call for fostering sustainable prosperity, competitiveness, and acceleration of innovation is underpinned by metrology, the science of measurement. Therefore, a strong and coordinated response from Europe's metrology community is required to enable the multitude of transformations that are underway.

In a greatly changed world where Europe is facing an ever-increasing variety of challenges, the needs for new metrology capabilities are evident. Areas where metrology is crucial in the coming decade include resilient society, sovereign and competitive industry, innovative technologies, low-cost energy supply, protection of the environment, decarbonisation together with mitigation and adaptation to climate change, zero pollution ambition, circular economy, digital transformation, health system transformation, and resilience of European infrastructures.

Cooperation between Member and Associated States through the network of National Metrology Institutes (NMIs) and Designated Institutes (DIs) is the only way to meet the upcoming needs on metrology. This collaboration is coordinated by [EURAMET](https://www.euramet.org), the European Association of National Metrology Institutes.

The challenges of the next decade require Europe's metrology community to level up its game on alignment of long-term research and innovation activities in Member and Associated States. Europe must bring together the world-class measurement expertise to continue creating scientific excellence, technical solutions for industry, competences where gaps are identified, and cohesion throughout Europe.

Taking into consideration the prerequisites above, this paper outlines EURAMET's vision of a European Metrology Agenda for the decade of 2030 to 2040. The first chapter demonstrates briefly 'Why metrology matters' by sharing examples of how measurement science is affecting all areas of modern society. In the second section background information on the tasks and international collaboration of NMIs and DIs and related investments is provided. The main chapter 'European dimension in metrology' focuses on four areas: 'Competitive and sovereign industry', 'Transition to a sustainable and resilient Europe', 'Health', and 'Infrastructures and cohesion'. In each part selected examples of upcoming needs requiring measurement science are listed and the necessary metrology research responses are defined. The conclusion summarises the findings of the previous chapters and emphasises the European metrology community's commitment to continue its strong collaboration for the benefit of Europe.

## 1. Why metrology matters

Reliable measurements are essential for innovation in economies and societies. The science of measurement, metrology, is vital for scientific research, trade, industry and human well-being. In our daily lives - from clean water, trading energy or having an X-ray at hospital to consumer protection, security, and transport – we rely on metrology. Modern society could not function without the science of measurement.

Metrology extends far beyond precise measurements, it accelerates innovation, fosters Europe's competitiveness and societal well-being.

### **Metrology Drives Competitiveness**

Metrology forms a foundational infrastructure that supports industries and creates favourable conditions for businesses to thrive. Accurate and reliable measurement is essential for manufacturing industry, ensuring the quality and efficiency of production processes. By enabling better processes, metrology allows organisations to increase their productivity. In fact, metrology represents a significant proportion of production costs, estimated to account for 10 to 15 percent in some industries. This highlights the crucial role it plays in maintaining economic efficiency and competitiveness.

Lower energy prices are strongly linked with the acceleration of the EU's competitiveness and the rapid transition to secure and clean energy sources is crucial. Metrology contributes to the optimisation of the energy production processes leading to a more cost-effective and sustainable energy production. Further, Europe's metrology community plays a key role in tackling the measurement challenges in introduction of renewable energy supplies to the gas and electricity grids. Clearly, new metrology is needed for the smart electricity grids and renewable energy gases.

### **Metrology Enables Innovation**

Innovation and measurement are intimately connected, with metrology serving as an enabler of advancements in strategic technologies and speeding up innovation cycles. Innovators rely on accurate measurement to develop and validate their new products and demonstrate their superiority to customers by providing objective proof of quality and performance. Furthermore, metrology plays a vital role in preventing market failures, especially for novel products, by helping to establish trust through quality assurance.

The metrology community has a track record of close collaboration with manufacturing industry and academia, for example within joint research projects or in specific technical areas. This needs-driven collaboration has paved the way for innovative developments, from new products and devices to improved methods and processes.

### **Metrology Facilitates the European Single Market**

In the context of the European Union's Single Market, metrology is indispensable. It ensures that goods and services meet standardised measurements, which reduces trade barriers. Without a unified system of measurement, businesses would face increased transaction costs due to the need for repeated testing and certification. Metrology provides a common framework that enables products to move freely across borders, meeting the same quality and safety documentary standards in all EU countries.

This standardisation allows suppliers to confidently market their products internationally, while buyers can trust that they are receiving exactly what is advertised. The consistency provided by metrology also helps prevent market distortions caused by information imbalances between buyers and sellers. For example, accurate weighing and measurement protect both parties in transactions, ensuring fairness and transparency in trade. By enhancing efficiency and building trust in product quality, metrology is a key driver of the Single Market's success and the global competitiveness of European industries.

A further example on how the European metrology community is supporting the Single Market are EURAMET's [Calibration and Technical Guidelines](#). They improve harmonisation of measurement instrument calibration, from drug delivery devices, automatic or non-automatic weighing instruments to digital multimeters. These guides provide state of the art knowledge and are freely available to be used by laboratories, manufacturers and other stakeholders.

### **Industry Needs Vocational Training in Metrology**

As technology evolves and industries become more complex, the demand for skilled professionals in metrology has grown significantly. Modern industries - from precision manufacturing to healthcare - require advanced measurement techniques and standards to ensure quality, compliance, and innovation. To meet these needs, vocational education and training in metrology are essential for developing the specialised expertise required to handle sophisticated equipment and interpret data accurately.

Today's industries rely on metrology experts to ensure that processes and products comply with regulatory standards, both nationally and internationally. As sectors such as automation, smart manufacturing, and healthcare continue to advance, so does the complexity of the measurement systems required to support them. This ongoing need for vocational training in metrology is critical for maintaining high-quality production standards and ensuring that Europe remains competitive in the global marketplace.

### **Metrology Ensures a Functional Society**

Beyond its industrial and economic impact, metrology plays a fundamental role in ensuring the safety, quality, and well-being of society. Consumers rely on accurate measurements for product quality, safety, and dosage accuracy in health-related goods. In the healthcare sector, precise measurement is essential for diagnosing medical conditions, applying treatments and monitoring their effectiveness, and ensuring the safety of medications. Accurate measurement is particularly important during public health crises, where it plays a key role in managing and tackling outbreaks.

Metrology also underpins environmental monitoring and sustainability efforts. It allows for the measurement of pollution, emissions, and climate-related phenomena, enabling scientists and policymakers to track environmental changes, respond accordingly, and evaluate the efficacy of the policies in place. From measuring meteorological conditions to tracking changes in the ozone layer or polar ice caps, metrology provides the support needed to address pressing environmental challenges and develop adaptation measures.

In the academic world, metrology supports research and is a core component of curricula in many scientific disciplines, helping to train the next generation of industry and research professionals. In finance, metrology enables each financial transaction to be accurately time-stamped to ensure traceable evidence of it and to ensure compliance with European financial regulations.

## **Metrology matters**

As demonstrated, metrology is essential for fostering innovation, driving competitiveness, supporting the functioning of the European Single Market, and ensuring the well-being of society. Metrology is about building trust, ensuring quality, and enabling progress across industries and nations. There is a need for a mechanism for the EU Member and Associated States to continue working together in the field of metrology. A coherent joint action will have greater impact at EU level and avoid fragmentation of activities and duplication of effort across the Member and Associated States. Without a joint action the resulting inadequate level of investment in Europe, coupled with the fragmentation of metrology capabilities and loss of strategic focus, would lead to a strategic vulnerability where the European economy would be dependent on third countries. In addition, it is important for societal cohesion that European citizens widely trust the measurements that are leading to political decisions, potentially affecting their lives or economies.

## 2. Background

The core mission of the National Metrology Institutes (NMI) and Designated Institutes (DI) is to provide national measurement systems to obtain accurate, fit-for-purpose and reliable measurements accepted worldwide. They provide metrology-related services for industry and stakeholders including traceability of measurement results to the international system of units (SI) under the Metre Convention and conformity assessments in regulated areas. Metrology, standardisation, accreditation, and conformity assessment together form the Quality Infrastructure that is fundamental for industry, society, and academia. EURAMET e. V., the European Association of National Metrology Institutes, with 120 NMIs and DIs from 39 countries, is the key organisation for European cooperation under the Metre Convention and the European Quality infrastructure.

Metrology at the level of National Metrology Institutes combines scientific excellence, the highest-level research and development, and technology infrastructures with a public service mission. Member States have a permanent mission to develop their metrological capabilities and solutions in response to the needs of industry and other stakeholders. Comprehensive research and development – in collaboration with each other and with other research and technology organisations, universities, and industry – keeps the measurement capabilities of the NMIs and DIs at the scientific forefront and ensures alignment with evolving stakeholder needs.

European Metrology Institutes of the Member and Associated States, including widening countries, have strongly benefitted from the collaboration within EURAMET, including coordination and joint research<sup>1</sup> conducted in the framework of the current European Partnership on Metrology and its predecessors. However, the anticipated challenges and capability gaps in the key areas described below have a dimension and complexity that requires deeper integration and a coherent implementation of this European Metrology Agenda in the next decade.

Globally, other regions are investing significant amounts in their metrology systems to meet the needs arising from global challenges and to support competitiveness of their industry.

In the United States, the National Institute of Standards and Technology (NIST) budget linked to NMI activities, from provision of measurement services to advanced research, is roughly 400 million dollars per year. This figure does not include NIST's Information Technology Laboratory that has significant activities in research and standards related to other emerging technologies such as artificial intelligence, cybersecurity, and privacy. Additionally, the United States Chips Act allocates up to 700 million dollars over five years to address the metrology needs of the semiconductor industry alone.

In China, the National Institute of Metrology (NIM) budget in 2023 is 206 million dollars, out of which direct government funding is 96 million dollars. The level of government funding is expected to remain stable for 2024. China has a distributed metrology system with municipal metrology institutes that are funded through the local governments. Their combined government funding is estimated to be comparable to the funding NIM receives.

The budget of the National Metrology Institute of Japan (NMIJ) is 50 million dollars per year. In addition, NMIJ has proposed a national research development programme providing additional

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<sup>1</sup> Involvement and use of European Metrology Programme for Innovation and Research EMPIR in the Czech Metrology Institute – a positive example of the use of European Cooperation," J. Tesar et al., Ukrainian Metrology Journal vol 2, pp. 33-39 (2023).

funding to vitalise the national economy and industry, contribute to the net zero emissions policy, and prevent pandemics.

The success of EURAMET lies in its role to pool and coordinate capabilities, and support capacity building to improve coherence in the region and avoid fragmentation. In Europe, a globally relevant level of investment can only be reached through coherent joint action to which the European NMIs and DIs are committed to.

In view of the above-described international benchmarks, the key for Europe will be to keep the scientific excellence and technical capabilities of its metrology community at the forefront of measurement science. Any response to the challenges of the next decade must be underpinned by fundamental and collaborative research. The metrology capabilities of Europe cannot come from the third countries, they must be developed in Europe.

### 3. European dimension in metrology

EURAMET has identified four key areas that frame the coordinated European Metrology Agenda in the decade 2030 to 2040:

1. Competitive and sovereign industry,
2. Transition to a sustainable and resilient Europe,
3. Health, and
4. Infrastructures and cohesion.

This new European Metrology Agenda is aligned with the European political agenda and addresses European countries' needs in the four identified key areas. Major objective of the agenda is to support the competitiveness and the resilience of European industrial ecosystems through metrology. This agenda includes cohesion actions to help European countries to meet their national needs, and vocational training for industry professionals. A coordinated investment in infrastructures is necessary to increase cohesion across Europe.

The agenda also calls for the metrology community to strengthen collaboration with partners of the European Quality Infrastructure in standardisation, regulation, legal metrology, and conformity assessment.

#### 3.1 Competitive and sovereign industry

##### ***Need***

Europe needs a resilient, competitive, and sovereign industry. Over the next decade, the European industrial base will evolve, and the metrology infrastructure will need to adapt to emerging needs. Europe is likely to focus on regionalising supply chains to improve resilience. This could lead to greater investment in local production capabilities, particularly in critical sectors like pharmaceuticals, semiconductors, and energy. Europe's push for strategic autonomy will drive efforts to reduce reliance on non-EU suppliers for critical resources and technologies. This will encourage the growth of domestic industries in areas like electric vehicle battery production, microelectronics, and sustainable energy solutions. In the global race for competitiveness, Europe is likely to lead in clean energy innovation, particularly in hydrogen, renewable energy storage solutions, and advanced energy grids. In advanced manufacturing, the next decade will see a surge in additive manufacturing, quantum technologies, and nanotechnology. These will open new opportunities for high-value, customised production, allowing Europe to maintain its competitive edge in precision industries like aerospace, medical devices, and high-performance materials.

Strategic technologies for Europe underpin these changes and are critical to keeping and developing the European industry base. Consequently, the EU has initiated actions to promote Europe's long-term competitiveness on strategic technologies, focusing on digital and deep technologies, clean technology, and biotechnology<sup>2</sup>. In addition, there are six Key Enabling Technologies identified by the Scientific Foresight Unit of the European Parliamentary Research Service as critical for Europe to reach technological sovereignty. These technologies are advanced manufacturing, advanced (nano) materials, life-science technologies, micro/nano-electronics and photonics, artificial intelligence, and security and connectivity

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<sup>2</sup> [https://commission.europa.eu/strategy-and-policy/eu-budget/strategic-technologies-europe-platform\\_en](https://commission.europa.eu/strategy-and-policy/eu-budget/strategic-technologies-europe-platform_en)

technologies<sup>3</sup>. These Strategic and Key Enabling Technologies, including quantum technology<sup>4</sup> are measurement intensive and/or need new metrological competences and capabilities for Europe to achieve or maintain a position of global leadership, and the ability to turn research and development into market products. Circular economy and a robust supply of critical raw materials will also be key for Europe's ambitions towards resilience and sovereignty.

As the European Commission President Ursula von der Leyen said in her State of the Union Address, "*Let's make sure that the future of our industry is made in Europe.*" Manufacturing industry in Europe is the largest customer and stakeholder community for EURAMET's members and associates. Industry needs services delivered by EURAMET members for their production, development, quality control, and conformity assessment. For example, there would not be European high-end lithography tools for microelectronics manufacturing without traceable sub-nanometre length measurements and capabilities at extreme ultraviolet wavelengths. Wide availability of metrology services and infrastructures for the Strategic and Key Enabling Technologies will create significant savings and competitive advantage for industry, and these capabilities shall be provided in Europe.

The transition to digital systems is common across all aspects of the economy and society. The most fundamental technical change associated to the digital transformation is the introduction of artificial intelligence, ubiquitous connectivity, distributed systems, and edge/cloud computing. Systems including these technologies require totally new metrology concepts for quality control and safety, and confidence in their outputs requires new approaches to assess the quality of data, which is important to lower costs and to foster the competitiveness of the industry. It is also important to highlight that metrology plays a crucial role in enabling trustworthy AI by establishing standardized metrics and methodologies for assessing AI systems. These developments are expected to continue with pace.

### ***Metrology response***

Objectives include:

- Strengthen the European industrial ecosystems<sup>5</sup> through new metrology capabilities and services for Key Enabling Technologies. Metrology for advanced manufacturing, micro- and nanoelectronics, quantum technology, and biotechnology are among the most important topics to address.
- Support development of new standards and technical regulations in international standardisation bodies to promote the competitiveness of European industry. Increased clarity in standards used for certification reduces the cost burden of certification.
- Support the implementation of the EU AI Act<sup>6</sup> regulatory framework through methods for quality control of data, metadata, AI training data and algorithms. The EU AI Act stipulates that high-risk AI systems should perform consistently throughout their lifecycle and meet an appropriate level of accuracy, robustness and

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<sup>3</sup> Key enabling technologies for Europe's technological sovereignty," a study by the Panel for the Future of Science and Technology, Scientific Foresight Unit (STOA), European Parliamentary Research Service, PE 697.184 – December 2021

<sup>4</sup> <https://digital-strategy.ec.europa.eu/en/library/european-declaration-quantum-technologies>

<sup>5</sup> [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy\\_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy_en)

<sup>6</sup> [TA \(europa.eu\)](https://eur-lex.europa.eu/eli/reg/2024/1110/oj) "In that context, in cooperation with relevant stakeholders and organisations, such as metrology and benchmarking authorities, the Commission should encourage, as appropriate, the development of benchmarks and measurement methodologies for AI systems. In doing so, the Commission should take note and collaborate with international partners working on metrology and relevant measurement indicators relating to AI."

cybersecurity. Beyond regulatory requirements, the quality of training data and algorithms is generally relevant to achieve trust and thereby benefit from all applications of AI.

- Directly deliver the SI at the point of use, by applying quantum and digital technologies to provide primary realisations of the units within an industrial or other users' facility.
- Development of advanced manufacturing metrology to support design for circularity, and research on emerging metrology to support reliability of circulated materials, reducing the carbon and material footprint of industrial production.
- To ensure the transition of quantum technologies research results into applications and acceleration of uptake in industry by metrology support to testing, validation, standardisation, and certification of quantum technologies.

### **3.2 Transition to a sustainable and resilient Europe**

#### ***Need***

Sustainability transformation, including green transformation of the energy infrastructure, tackling the loss of biodiversity and climate change as well as mitigating its effects, will be of high priority for Europe in the coming decades<sup>7</sup>. These challenges call for new measurement technologies and improved reference standards underpinning green and sustainable industrial innovation and the development and implementation of technologies and products with smaller life cycle footprints, especially in the areas of energy production and energy-intensive industrial processes. These will require control through associated regulation. Tackling climate change and preserving the environment will call for more difficult and complex measurement capabilities such as for pollutants, climate and ocean variables and comprehensive, systemic views on them. Furthermore, measurement and understanding of the global and regional effects of actions against climate change will have huge impact as societies spend great amounts on mitigation actions.

The Green Deal Industrial Plan calls for global cooperation and open trade for the green transition, under the principles of fair competition. Metrology is a key enabler for open trade and a way to reduce technical barriers to trade through the CIPM [Mutual Recognition Arrangement](#). Europe must be active in developing the necessary metrology solutions to enable Free Trade Agreements and other forms of cooperation with the partners of the EU to support the green transition. EU to support the green transition.

The Net-Zero Industry Act of the Green Deal Industrial Plan aims to identify goals for net-zero industrial capacity and provide a regulatory framework where the role of measurement is evident. Linked to the Green Deal, the REPowerEU plan addresses the need to end Europe's dependence on gas, oil and coal, while accelerating the energy transition and strengthening the security of supply and storage of energy. The main actions in the REPowerEU package include energy saving, diversification of supplies, substitution of fossil fuels, and investments and reforms. The regulatory measures of the

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<sup>7</sup> [https://commission.europa.eu/system/files/2020-11/rtd\\_sp\\_2020\\_2024\\_en.pdf](https://commission.europa.eu/system/files/2020-11/rtd_sp_2020_2024_en.pdf)

REPowerEU<sup>8</sup> will include regulatory measures to increase energy efficiency and a regulatory framework for hydrogen, both requiring new measurement solutions.

The EU's biodiversity strategy for 2030, which is a long-term plan to protect nature and reverse the degradation of ecosystems, and the Farm to Fork Strategy, aiming at making food systems fair, healthy and environment-friendly, will also reach into the next decade. These challenges will require strong and new chemical metrology capabilities.

### ***Metrology response***

Objectives include:

- Enable the green energy transition through improvements in measurement for production of electricity, heat, and carbon neutral gases and fuels including CO<sub>2</sub> derived products.
- Measurement solutions for energy transport, storage, metering, and efficient use in increasingly diverse, coupled, and complex energy systems with significant micro-generation and for new requirements on grid stability and security.
- Support the regulatory frameworks of the European Green Deal and the REPowerEU plan where measurement data is relevant, and aid European companies in meeting the regulatory requirements in a competitive way.
- Support evidence-based policy making to mitigate the effects of climate change through improvements in metrological traceability of data used in policy making and assessment of the effectiveness of policy actions on regional and global levels.
- Develop improved measurement solutions for high quality climate and ocean variables observations.
- Develop measurement capabilities for clean air and water, and healthy soil, including improved monitoring of priority and emerging pollutants and effects from the local production of energy.
- Underpin trust in the measured values by developing methods for seamless sharing of digital data and metadata and methods for propagation of uncertainty through complex digital processing chains as relevant, e. g., for complex measurement and modelling scenarios.
- Development of new reference materials and laboratory practices for healthy and affordable food and support food industry in transition from animal proteins to plant-based or synthetic proteins.
- Supporting quality infrastructure for the circular economy through development of metrology for accurate assessment of material properties, facilitating recycling and promoting resource efficiency. The quality infrastructure for circular economy, in turn, promotes trust in circularity, enhances product durability, and reduces waste.

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<sup>8</sup> [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe\\_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en)

### 3.3 Health

#### **Need**

“One Health” is a comprehensive approach promoted by WHO to optimise the health of people, animals and the environment<sup>9</sup>. This approach aims at preventing, predicting, detecting, and responding to global health issues through horizontal collaborative actions across multiple sectors. In addition to legislation and policies, cross-disciplinary research is needed to achieve the goals of One Health. Areas of work include laboratory services, environmental health, control of diseases and antimicrobial resistance.

The One Health approach is particularly relevant for fighting pandemics, like the COVID-19 pandemic, which demonstrated vulnerabilities in protecting Europe’s citizens and economy.

Accordingly, the healthcare and biotechnology sectors are expected to expand. Investment in biotech, pharmaceutical research, and personalised medicine will grow, driven by advances in genomics, AI-driven diagnostics, and biomanufacturing, generating metrology needs to underpin quality control in diagnostics, clinical analytics and the health and pharmaceutical industries in Europe. Metrology is particularly important when data from different countries are combined, which requires known accuracy and uncertainty of underlying measurements. This also has a major impact on the activities of the European Health Data Space.

In parallel, the effect of the aging population on European health systems will be accelerated. The decade 2030 to 2040 will be the decade in which a baby-boomer generation will retire, straining the available resources. This necessitates a shift from a ‘one size fits all’ approach towards considering individual differences and better utilising the accumulating data to manage health. Respective metrology needs will include quantitative measurements with high precision to detect individual differences, quality-assured digital tools, support for the manufacturing of novel pharmaceuticals and medical devices for personalised treatments as well as quantitative measurements for assessing individual treatment responses.

Significant effort is required to support innovation through health care regulatory frameworks (EU- IVDR and MDR). In particular, new approaches are required to exploit the potential of digital health technologies and artificial intelligence by accelerating regulatory approval in the EU (AI-Act).

#### ***Metrology response***

Objectives include:

- Support for quality control in the health domain, including new metrology for (nano-based) pharmaceutical production, quantitative medical imaging, diagnostics, analytics, therapy, and medical devices.
- Development of improved measurement solutions and certified reference materials for medical applications.

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<sup>9</sup> <https://www.who.int/europe/initiatives/one-health>

- Development of metrology methods for assessment of data quality and data management in eHealth and in Health Data Spaces, including algorithms and the use of artificial intelligence in healthcare and metrological support to the EU AI Act regulatory framework.
- Support to objective and evidence-based decisions on individual health plans allowing shifting towards more proactive, accurate, and patient-centred healthcare by developing metrology to improve the reliability of health data.
- Support to the health care regulatory frameworks such as for in-vitro diagnostics and medical device regulation. Support to market entry of new technologies and devices within the regulatory frameworks.
- Development of new metrology to support to cutting-edge medical and biotechnology research to ensure their implementation and standardisation. Examples of targeted fields include molecular diagnosis, biopharmaceuticals, nanomedicine, and tissue engineering.

### 3.4 Infrastructures and cohesion

#### **Need**

European National Metrology Institutes and Designated Institutes own and operate a significant number of technology infrastructures that provide services to industry and other stakeholders at national, regional or European level. In line with the [EURAMET strategy<sup>10</sup>](#) this agenda aims at developing a balanced and integrated metrology system for Europe. However, there are limited national resources to invest in new facilities/infrastructures. Further integration through coordinated development of European infrastructures, supported by Member States and European Union alike, would leverage the benefits of the research actions. Such infrastructures would support and motivate the provision of coordinated services, enable capacity building, and provide means for the NMIs and DIs to respond to needs arising from the security and defence sectors.

The disparities among the European countries are still significant. In addition, several countries seek membership of the EU. The EU's cohesion policy underpins European solidarity and focuses on the less developed European countries and regions to help them to reduce the disparities<sup>11</sup>. Many European NMIs and DIs represent the cutting-edge of global measurement expertise, having a leading role in supporting the global competitiveness of the European economy as well as the development of measurement technologies required by a modern society. Other national institutes are in the early development stages, more service-oriented, or have limited resources but still must keep up with their stakeholders' needs. Strengthening the scientific and technical capabilities of small and emerging NMIs, capacity building activities, and infrastructure improvements aimed at smart specialisation at national or regional level are vitally important to many Member and Associate States. In line with the EURAMET strategy<sup>12</sup> the objective is to bridge the gap between members and to cover competence gaps at European level, thus developing a balanced and integrated metrology system and infrastructure for Europe. The 39 EURAMET member countries extend beyond the European Union and include countries currently aspiring to join the EU and potential candidates. EURAMET is in an

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<sup>10</sup> <https://www.euramet.org/about-euramet/strategy-2030>

<sup>11</sup> [https://ec.europa.eu/regional\\_policy/policy/what/investment-policy\\_en](https://ec.europa.eu/regional_policy/policy/what/investment-policy_en)

<sup>12</sup> <https://www.euramet.org/about-euramet/strategy-2030>

extraordinarily good strategic position to contribute to cohesion.

### ***Metrology response***

Objectives include:

- Continue the work of European Metrology Networks<sup>13</sup> under EURAMET to develop the metrology infrastructures in Europe according to the stakeholder needs, create joint service provision, and cover competence gaps in the topical fields of the networks.
- Development of Open Testing and Validation Facilities for quantum technology for assessment and measurement of quantum devices, additionally providing metrological support for quantum sensors and standardisation efforts to establish a comprehensive quality assurance chain.
- Promotion of vocational training in industry. Training needs include practical skills in calibration and measurement techniques, industry-specific applications of metrology, digital metrology, as well as international standards and compliance.
- Promotion of European cohesion through development of individual and institutional capabilities. This would include hands-on experience, training, and mentoring through secondments and researcher mobility in technical areas where high infrastructure costs, low availability of experienced staff, or lack of scientific excellence is a barrier for a developing institute to work in the field.
- Correcting imbalances in the metrological scientific excellence between the Member and Associate States and regions through an implementation structure that promotes participation of the less advanced beneficiaries in research projects of high scientific excellence.
- Supporting the quality infrastructure in Ukraine and its development towards EU standards in close cooperation with CEN/CENELEC, EA, and WELMEC.

Further technology infrastructures providing industry with the facilities needed to test, validate and upscale innovation could be envisioned, e.g. towards metrology for AI and quality of data where competence gaps still exist.

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<sup>13</sup> <https://www.euramet.org/european-metrology-networks>

## 4. Conclusion

Metrology is a strategically important cross-cutting science. Without modern metrology infrastructure and capabilities for industry and society, Europe will not remain competitive to other regions in the world and will lack the ability to respond to the societal challenges that need to be addressed globally. This European Metrology Agenda is aligned with the broader European agenda and addresses Member State metrology needs towards competitiveness, sustainability, and resilience of the European industry and society.

Other regions of the world are investing significant financial amounts in their metrology systems to meet the needs arising from global challenges and to support competitiveness of their industry. In Europe, a similar level of investment can only be reached through a coherent joint European action. Manufacturing industry in Europe is the largest customer and stakeholder community for EURAMET and its membership. Metrology is a key part of the quality infrastructure that is essential for industrial manufacturing, innovation, competitiveness, standardisation, trade, and access to global markets. It would be a strategic vulnerability if Europe's industry and society depend on metrology support from third countries.

Scientific excellence is the key to meeting the objectives of this agenda. Excellence can only be reached through cutting-edge joint research, expertise, capabilities, and fit-for-purpose infrastructures. Strengthening the scientific and technical capabilities of the small and emerging NMIs and DIs, cohesion activities, and infrastructure improvements aimed at smart specialisation at national or regional level are vitally important to many Member and Associate States. The European Metrology Networks have proven to be an effective tool to interact and deliver research impacts to a broad range of stakeholder communities, making services and capabilities readily available. Wide availability of metrology services and infrastructures on the Strategic and Key Enabling Technologies will create significant savings and competitive advantage to the European industry.

The current and previous research programmes have had and continue to have a strong impact on the national metrology infrastructure developments in Europe. Research supported by the EU has created scientific excellence and has brought European metrology research into an internationally leading position in the spearhead fields. In addition, research programmes have leveraged national investments; it is estimated that about half of the national investments in the capabilities of metrology infrastructures are triggered or influenced by the joint projects and the joint Strategic Research Agenda developed by EURAMET.

The next decade will provide major challenges that require a joint, coordinated response of the European metrology system. The European National Metrology Institutes and Designated Institutes are committed to continue their cooperation under EURAMET.

EURAMET e.V.  
Bundesallee 100  
38116 Braunschweig  
Germany

Phone: +49 531 592 1960  
Fax: +49 531 592 1969  
E-mail: [secretariat@euramet.org](mailto:secretariat@euramet.org)

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