



TOGETHER
for a sustainable future



THE ROLE OF METROLOGY IN THE CONTEXT OF THE 2030

SUSTAINABLE DEVELOPMENT **GOALS**

Chemical metrology is a relatively new area that is witnessing rapid development. The advantages that a rigorous measurement approach can bring to addressing food safety, health and environmental goals are being increasingly recognized. Accurate chemical measurements are critically important yet the metrology is challenging. National Metrology Institutes (NMIs) must provide the cornerstone that underpins national chemical measurement and testing capabilities throughout their country. Historically, only the advanced nations supported significant chemical metrological capabilities. However, expectations related to trade, for example regulations related to trace levels of contaminants in food and foodstuffs or for environmental protection and the monitoring of climate change, will result in all countries having to develop chemical metrological capabilities at an appropriate level for their economy.

Expertise in chemical measurement is essential for effective collaboration with, and to meet the expectations of, international stakeholders such as the World Health Organization (WHO), Codex Alimentarius and the World Meteorological Organization (WMO), and to underpin laboratory accreditation. NMIs do not need to provide all capabilities themselves; by effective engagement in the CIPM Mutual Recognition Arrangement (CIPM MRA) they can rely on the capabilities of other participants.

MEASUREMENTS AND POVERTY REDUCTION

1 NO POVERTY



The regulation of measurements by governments through a legal metrology system aims to ensure a level playing field for all in many fields of measurement.

At the most basic level, making trade fairer, even in the smallest markets, will ensure that all farmers receive the correct payment for their produce, and that all consumers will receive the correct amount of goods for their money. The control of prepacked goods will also help to reduce fraud in this increasingly important area which often concerns staple foodstuffs. The correct measurement of raw materials exported in bulk may ensure that not only is the correct price paid, but that governments are able to collect the correct taxes on exports.

Applying legal metrology controls to measurements which affect road safety, such as speed, blood alcohol and vehicle overloading, can reduce accident rates. Road accidents disproportionately affect the young, the old, and the poor, and apart from the human cost, can lead to a significant drain on scarce national resources which could otherwise be used constructively for the benefit of all. For example, overloaded vehicles will not only destroy costly road infrastructure which was not designed to cope with their weight, but are more likely to be involved in accidents since their braking systems were also designed for a given vehicle weight.

In the field of health, accurate measurement of even the most basic parameters, such as the patient's weight, temperature and blood pressure can lead to more accurate diagnoses and thus to improvements in the health of even the poorest people, thus reducing the cost to national finances.

Over the long term, legal metrology controls in all of these areas will improve economic conditions for all concerned and assist in poverty reduction.

3 GOOD HEALTH AND WELL-BEING



MEASUREMENTS FOR HEALTH

Medical measurements are an everyday part of healthcare and are fundamental to the prevention, diagnosis and treatment of diseases and other medical conditions. Population growth, longer life expectancy, increasing international travel and trade, as well as innovations in modern medicine are placing an ever growing demand on healthcare systems and nowhere are the pressures more keenly felt than in developing countries. Getting the measurements right improves patient outcomes, saves time and reduces costs.

Guidelines and regulations that cover medical equipment and methods can only be relied on if the measurements used to verify their compliance are accurate, traceable to internationally agreed reference measurement standards, and performed using approved and correctly calibrated instruments. Human health and safety depend on reliable measurements in diagnosis and therapy. Dosing of drugs or the measurement of radiation in radiotherapy, food safety and many other fields require measuring operations that are vitally important activities for public health. Internationally recognized and accepted equivalence of measurements in laboratory medicine and traceability to appropriate measurement standards will lead to:

- improvements in the quality of healthcare for the patient,
- reduction in 'false positive' and 'false negative' test results,
- reduction in costs for governments and healthcare insurers and an improvement in the efficiency of health care,
- reduction in the number of repeat tests due to improvements in quality,
- reduction of costs for the in vitro diagnostic (IVD) industry,
- removal of redundant written standards by unification of regional standards, and
- global acceptability of measurements and tests, which removes technical barriers to trade.

It is vitally important for clinical trials and for research that combines studies and data across borders, that the measurements and tests produce reliable and comparable results, independent of where the measurements are made.

THE ROLE OF METROLOGY IN THE 2030 DEVELOPMENT AGENDA

GENERAL EXAMPLE – IONIZING RADIATION METROLOGY

The metrology required to underpin measurements of ionizing radiation is particularly challenging for developing countries. It requires complex facilities that work under strict regulatory regimes and with structured outreach to hospitals and other stakeholders. Yet it has a high impact on health (radiotherapy, radio diagnostics and nuclear medicine) as well as on environmental radioactive monitoring (soils, water and atmosphere). Comparisons are difficult (handling radionuclides, short half-lives, radiation beams) and they rely on the world-wide unique reference systems operated by the BIPM and the International Atomic Energy Agency (IAEA). Measurement uncertainties directly impact the user community, for example treating cancer with beam therapy is a fine balance between killing cancer cells whilst minimizing damage to healthy tissue.



EXAMPLES OF HOW METROLOGY CAN SUPPORT SPECIFIC SDGS

MEASUREMENTS FOR CLIMATE CHANGE

13 CLIMATE ACTION



Accurate measurement is central to understanding climate change. The challenge for the climate change community, put simply, is to identify long-term trends of small magnitude from data that can vary enormously over very short timescales. A typical twenty-four hour period might see temperature changes of 20 °C or more, so detecting a change of 1 °C and extracting it from the signal ‘noise’ consistently over a period of a few decades requires a rigorous metrological approach. The difficulties are not trivial. Millions of measurements are made every day covering some 50 Essential Climate Variables. These measurements are made using different techniques (for example satellite sensing and surface measurement of temperature) and by many different parties across the world. The data has to be consistent so that it is meaningful and can be combined. The required quality is achieved by making measurements that are fully traceable to SI units, ensuring stability of measurement over time (allowing analysis over long time scales) coupled with known, well characterized and appropriately low measurement uncertainty.

The parameters requiring measurement in order to monitor the Essential Climate Variables span the following domains:

- atmospheric – surface and air temperature, wind speed and direction, water vapor, pressure, precipitation, surface and earth radiation,
- oceanic – sea-surface and sub-surface temperature, salinity, current and ocean acidity, and
- terrestrial – albedo, fraction of absorbed photosynthetically active radiation, groundwater, lakes, snow cover, glaciers and ice caps, ice sheets and land cover.

Advanced economies are able to collect data at the required geographic coverage and quality levels, but this is not always the case for developing countries. Furthermore, the emergence of emissions monitoring, carbon trading and other technologies such as carbon capture and storage all bring their own measurement challenges.

Physical metrology addresses mass and associated quantities such as pressure, flow and force as well as temperature and electrical and dimensional measurements and the provision of a national time scale. These factors are ubiquitous and cross all market sectors and technologies. The services they support underpin just about every area of human endeavor. As part of the establishment of its national infrastructure, an NMI that is able to provide physical metrology services, is a key priority for any developing country. In advanced countries the metrological traceability chain begins with the NMI undertaking primary realizations of the appropriate base units. However, where budgets are limited it is perfectly adequate to have national standards that are of a high level, though not themselves primary (and are metrologically traceable to such primary realizations elsewhere). The important point is for the NMI to be able to provide the most crucial measurement and calibration services needed to allow a developing economy to add value to its products and services, and to support measurement regulatory goals. Such an NMI will aim to obtain international recognition for those capabilities by participating in the CIPM MRA, which also provides a great way to benchmark and improve its national capabilities. The NMI will be able to demonstrate its capabilities by participation in international comparisons and engaging effectively in the world-wide system of measurement coordinated by the BIPM, as well as underpinning (and often providing) legal metrology services to support regulated measurements and instruments.

MEASUREMENTS FOR AFFORDABLE AND CLEAN ENERGY

7 AFFORDABLE AND CLEAN ENERGY



Energy is the lifeblood of modern society - we use it for many purposes including industry and transport, heating our homes, lighting and powering digital communications. However, the limited remaining resources of carbon-based fuels and the impact they have on the environment via CO₂ emissions, is driving us towards a transition to a low-carbon supply, to ensure a safe, affordable and sustainable energy supply for future generations. Society demands electricity supplies that are secure, sustainable and of high quality. In the future, the world will be facing potential energy shortages as oil and gas supplies run low and nuclear power facilities continue to age. Pressure to reduce greenhouse gas emissions will result in greater interconnection of renewable energy generation, the development and deployment of energy-efficient appliances, energy management and improved efficiency in electricity distribution. Increased use of renewables creates challenges for distribution grids, both in terms of grid stability but also due to the requirements of commerce for an electricity supply of the highest quality, free from momentary voltage interruptions or interference sources. Measurements play an increasingly critical role at every stage of the energy challenge.

Metrology is essential in many areas, for example:

- establishing the caloric value of natural gas,
- overcoming challenges related to the emerging hydrogen economy (for e.g. measurements of impurities in hydrogen),
- ensuring transmission grid stability with non-classic wave form inputs (for e.g. from solar panels and wind turbines),
- evaluating and improving the performance of fuel cells,
- characterizing chemico-physical properties of biofuels,
- addressing challenges related to the increased use of energy from bio waste, which may require biological as well as calorific value measurements,
- optimizing the control of energy storage systems (for e.g. batteries in the automotive sector), and
- ensuring fair metering of electricity, gas and automotive fuels.

9 INDUSTRY INNOVATION AND INFRASTRUCTURE



MEASUREMENTS FOR INNOVATIVE NEW PRODUCTS

High-performance products and manufacturing systems require accurate measurements for a wide range of parameters and production environments. “If you can’t measure it, you can’t make it!” In order to control their manufacturing processes and guarantee the quality of their products, companies are constantly concerned with aligning their instruments to reference standards and ensuring measurement traceability. Industry in developing countries begins by producing basic goods for local markets, and then adds the ability to assemble products, before graduating to the design, development testing and certification of truly home-produced products that are suitable for export. Effective metrology facilitates this ‘added value’ journey. Thus the ability to develop and deploy appropriate metrological methods and techniques via an effective measurement infrastructure is key for industry, supporting product innovation, process improvement and quality assurance. The economic success of nations depends upon the ability to manufacture and trade precisely made and tested products and components that are accepted by trading partners.

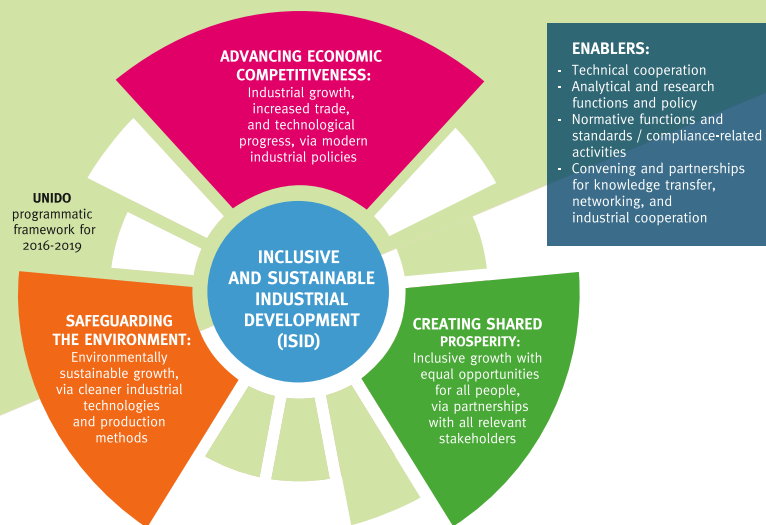
For developing countries the challenge is characterized by the ability to provide the measurement infrastructure that underpins or directly performs effective calibration and testing to ensure that:

- components and finished products meet regulatory requirements, documentary standards and specifications,
- consumer and industrial quality expectations are met, including product value/price and reliability,
- all interoperability requirements are satisfied, and
- conformity assessment can be effectively demonstrated, typically through the use of the CIPM MRA and for commercial laboratories, accreditation, leading to measurement and test results that are internationally recognized and accepted, thus avoiding trade barriers through repeat testing.

UNIDO's vision to address today's economic, social and environmental challenges is enshrined in the Lima Declaration, adopted by UNIDO Member States in December 2013. On this basis, UNIDO pursues "Inclusive and Sustainable Industrial Development" to harness industry's full potential to contribute to lasting prosperity for all.

The 17 Sustainable Development Goals (SDGs) with 169 associated targets constitute the core of the UNIDO 2030 Agenda for Sustainable Development. These provide a new development framework that seeks to transform the world and guide all global, regional and national development endeavors for the next 15 years.

Maintaining strategic partnerships and technical cooperation, together with the use of standards and compliance related activities, form an important part of UNIDO's approach. The relationship between UNIDO, the International Bureau of Weights and Measures (BIPM), and the International Organization of Legal Metrology (OIML) is one such strategic partnership. The aim of the partnership is to enhance the impact of industrial development on economic growth and to minimize technical barriers to trade (TBT) which are still a major obstacle to exports from developing countries and countries with economies in transition.



THE ROLE OF METROLOGY

Metrology is the "science and practice of measurement". An effective metrology system is characterized by the ability to properly calibrate measuring instruments with measurement uncertainties that are fit for purpose, against an appropriate reference (usually the the International System of Units, or the SI) via national standards (or certified reference materials). Essential factors for such a system are:

- traceability to the SI, where possible or not yet possible, or internationally agreed reference materials or procedures,
- regulated measurements and measuring instruments, and
- confidence in testing and measurement results via certification, standardization, accreditation and calibration.

To be useful measurements must be stable, comparable and coherent to be able to increase knowledge, protect people, enable industries to be innovative and competitive as well as govern transactions and trade. Metrology is a key part of the global "quality infrastructure" that underpins world trade.

Metrology is essential for trade, scientific comparison, innovation and emerging technologies, technical cooperation, or even simple exchange of information. In a rapidly growing world there is a continuing increase in requirements for improved measurement standards, and for the adoption of metrological concepts in new areas such as chemistry, nanotechnology, biosciences, medicine, food and the environment.

National and international trade increasingly requires demonstrated conformity to written standards and specifications and mutual recognition of measurements and tests. The CIPM MRA is the framework through which NMIs demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates that they issue. The CIPM MRA underpins wider agreements aimed at reducing trade barriers and improving the quality of measurement. The OIML has developed a new voluntary Certification System (OIML-CS) which aims to facilitate, accelerate and harmonize the work of national and regional bodies responsible for the type approval of regulated measuring instruments. Participating in the OIML-CS will commit, in principle, its signatories to accept and utilize OIML type evaluation and test reports, associated with an OIML Certificate, in their metrological controls. The new OIML-CS comes into operation on 1 January 2018 and will replace the OIML's existing Basic Certificate System and Mutual Acceptance Arrangement (MAA).



UNIDO has extensive experience in assisting countries to strengthen their competitiveness in global markets through capacity-building in quality, environmental sustainability, and social accountability requirements in accordance with international management systems standards and private sector requirements. UNIDO seeks to build up the national and regional quality infrastructure needed to provide internationally recognized quality assurance services. It provides services to strengthen national capacities to establish the legal and institutional frameworks for standards and conformity assessment. Specifically, UNIDO provides policy guidance and institutional capacity-building interventions related to standards, metrology, testing, inspection, certification and accreditation, which are needed to participate effectively in the multilateral trading system. The demonstration of market compliance enables exporters to reduce the cost of compliance and facilitates access to global markets. Assistance is also provided to strengthen consumer authorities and consumer associations in developing countries.



The BIPM is an intergovernmental organization established by the Metre Convention, through which Member States act together on matters related to measurement science and measurement standards. The mission of the BIPM is to work with the NMIs of its Member States, regional metrological organizations (RMOs) and strategic partners worldwide and to use its international and impartial status to promote and advance the global comparability of measurements, including providing a coherent international system of units for scientific discovery and innovation, industrial manufacturing and international trade and sustaining the quality of life and the global environment. The objectives of the BIPM are:

- to be the coordinator of the world-wide measurement system, ensuring it provides comparable and internationally accepted measurement results.
- to represent the world-wide measurement community, aiming to maximize its uptake and impact, and
- to be a center for scientific and technical cooperation between Member States, providing capabilities for international measurement comparisons on a shared-cost basis.

Fulfilling this mission and the objectives of the BIPM is underpinned by its work in:

- capacity building, which aims to achieve a global balance between the metrology capabilities in Member States, and
- knowledge transfer, which ensures that the BIPM's work has the greatest impact.

In 1999 the General Conference on Weights and Measures (CGPM) recognized that many developing countries were not yet ready to accede to the Metre Convention and become Member States of the BIPM. Consequently it created a new status of 'Associate State' to allow such countries to participate in the CIPM MRA, and as a stepping stone to becoming Member States.



The mission of the OIML is to enable economies to put in place effective legal metrology infrastructures that are mutually compatible and internationally recognized, for all areas for which governments take responsibility, such as those which facilitate trade, establish mutual confidence and harmonize the level of consumer protection worldwide. The OIML is an intergovernmental treaty organization which:

- develops model regulations, standards and related documents for use by legal metrology authorities and industry,
- provides mutual recognition systems which reduce trade barriers and costs in a global market,
- represents the interests of the legal metrology community within international organizations and forums concerned with metrology, standardization, testing, certification and accreditation,
- promotes and facilitates the exchange of knowledge and competencies within the legal metrology community world-wide, and
- cooperates with other metrology bodies to raise awareness of the contribution that a sound legal metrology infrastructure can make to a modern economy.

