
UNIDO
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
SUSTAINABLE DEVELOPMENT & THE FUTURE OF QUALITY INFRASTRUCTURE

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DISCLAIMER

FOREWORD

The importance of quality infrastructure in achieving inclusive and sustainable industrial development (ISID) and the Sustainable Development Goals (SDGs) cannot be overstated. This publication demonstrates how quality infrastructure systems contribute to the achievement of three of the 5Ps of the SDGs: People, Prosperity, and Planet, relating this to examples and case studies compiled on the topic. This publication also highlights the challenges developing countries face, and how quality infrastructure enables them to overcome them.

Quality infrastructure is defined as a system contributing to governmental policy objectives in areas including industrial development, trade competitiveness in global markets, efficient use of natural and human resources, food safety, health, the environment and climate change. Supporting the efforts to contribute to the SDGs and measuring the progress in achieving the specific targets requires robust quality infrastructures with all the building blocks in place: standardization, metrology, accreditation, conformity assessments (in particular testing, certification and inspection services) and market surveillance. An appropriate quality infrastructure is a fundamental pillar of the 2030 Agenda for Sustainable Development, and has the ability to support achievement of each of the SDGs. It contributes to prosperity by stimulating trade competitiveness, industrial development and innovation, to meeting the needs of people by ensuring food safety, supporting food security and promoting good health and well-being, and protecting the planet through the efficient use and sustainable management of natural resources, climate action, policies and programmes aimed at protecting the biosphere.

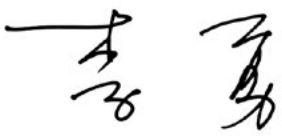
The ability of developing countries to harness the commercial opportunities, to compete in global markets and participate in international value chains is often challenged by their difficulties to demonstrate compliance with quality requirements and trade rules. UNIDO helps to tackle these challenges by working with them to set up a Quality Infrastructure System. Such a programme is one of the specialized services that UNIDO provides to promote Inclusive and Sustainable Industrial Development (ISID). This approach provides developing countries and economies in transition opportunities to alleviate poverty and progress towards sustainable development. ISID has the potential to support through the strengthening of the country's industrial base which can act as a platform for social inclusiveness, economic competitiveness, environmental sustainability and integration with the global trading system.

This publication will show that as various components of quality infrastructures develop, they could evolve independently and result in an overlap in functions and responsibilities. A basic cornerstone for ensuring good governance of quality infrastructure is to also have in place, a set of quality policy (QP), which is a means to reform, consolidate, refine and maintain an effective quality infrastructure. Quality policy actively promotes a culture of quality to bring sustainable balance between the infrastructure offered and the demand for quality services. When properly designed and applied, it would contribute substantially to the attainment of the SDGs.

The publication builds on three other complementary brochures that were published in 2016 and 2017; "The Role of Standards in the Context of the 2030 Sustainable Development Goals", "The Role of Accreditation in the Context of the 2030 Sustainable Development Goals", and "The Role of Metrology in the Context of the 2030 Sustainable Development Goals".

UNIDO has an extensive and proven track record working with government, industry and other major stakeholders in developing countries to build quality infrastructure systems, helping countries address their quality infrastructure gaps and needs. The approach by UNIDO is holistic, where our intervention expands from raising awareness of quality infrastructure to helping member states establish and operationalize the system. UNIDO, together with the International Network on Quality Infrastructure (INetQI), is committed to promoting and accelerating ISID with the aim of enhancing the capacity of our member countries to meet market and society needs in line with the SDGs.

Looking into the future, quality infrastructure institutions and services will need to be strengthened and expanded to meet new requirements, to help consumers make informed choices, encourage innovation and lead businesses and industries to adopt appropriate technologies and organization methods. This is likely to help improve current practices and support public authorities in designing and implementing public policies that are aligned with the SDGs.



Li Yong, UNIDO Director General

EXECUTIVE SUMMARY

The information and examples provided in this report are intended to help provide insights and examples of how a quality infrastructure (QI) supports and underpins the implementation of the Sustainable Development Goals (SDGs). It outlines how QI systems better position developing economies to meet the SDGs by creating economic prosperity through inclusive economic growth, safeguarding the well-being of people and protecting the planet.

UNIDO's approach to QI development is systemic and holistic, from building awareness to helping initiate, develop and strengthen a fit-for-purpose QI that runs efficiently and is cost-effective. Together with partners from the public and private sector, academia, national and international organizations in charge of standards-setting and global practices on metrology, standards and conformity assessment, UNIDO promotes good practices, capacity building and training, and fosters global cooperation in standards-setting, measurement and compliance development along value chains.

QI IN SUPPORT OF THE SDGS - A national QI comprises institutions in charge of metrology, standardization, accreditation, market surveillance and conformity assessment, as well as the related policy, services and legal and regulatory frameworks. Establishing an appropriate QI system can substantially assist a nation in positioning their economy to seize the many opportunities available through the appropriate implementation of the SDGs.

A QI contributes to 3 of the SDG themes: People, Prosperity, and Planet. These themes strongly emphasize the interdependence of the various goals, targets and approaches, and the need to implement them in an integrated manner. Economic activities and economic development are at the core of human activity and essential drivers of prosperity, yet at the same time they depend on the resources of the biosphere and are responsible for its unsustainable exploitation.

ECONOMIC GROWTH THROUGH TRADE – A QI crucially supports the enablement of effective domestic markets, facilitates access to foreign markets and helps to promote sustainable economic development. For successful trade, manufacturers need to ensure that their products are of consistent quality, comply with relevant standard and meet the necessary destination and consumer requirements / specifications. Furthermore, the 2030 Agenda for Sustainable Development recognizes international trade as an engine for economic growth and poverty reduction. The efficient attainment of public goals using a national quality policy (NQP) ensures that any subsequent regulatory measures are prepared, applied in ways that encourage the required change and do not create unnecessary barriers to international trade.

Inclusive and Sustainable Industrial Development (ISID) and Innovation - QI institutions and the support services they provide have a fundamental role in promoting prosperity by supporting the development of industry and infrastructure, which in turn promotes economic growth. A QI contributes to innovation by fostering the development and broad dissemination of new technologies or products in line with established best practices. This in turn generates greater employment and fosters socio-economic development. The insightful and cost-effective implementation of standards by competent authorities can also improve the ecological performance of materials and products and support their energy efficiency. In this way, a QI advances environmentally sustainable growth by building institutional capacities including those needed for the development and adoption of cleaner technologies for production.

MEETING THE NEEDS OF PEOPLE - Metrology provides trusted measurement data that helps ensure that compliance with consumer and regulatory requirements is transparent, reliable and meets expectations, to the benefit of all.

Food Security and Sustainable Agriculture - The future of agriculture presents some particularly daunting and diversified challenges. For countries with a high population density and limited agriculture, a key objective is to achieve high crop productivity and resource use efficiency to ensure food security coupled with environmental sustainability. For the least developed countries (LDCs) the overarching goal is to eradicate hunger and to secure adequate nutrition to all people. Therefore, QI institutions and the services they provide have a fundamental and demonstrable role in the support of trade in food and agricultural products. They ensure that food is fit and safe for consumption and is grown in a sustainable way, which in turn allows people to live healthy lives and improve their social and economic well-being.

Good Health and Well-being - A QI plays a pivotal role throughout the health sector, specifically with regards to inputs, processes or activities. Guidelines and regulations that cover medical equipment and methods can only be relied on if the measurements and processes used to verify their compliance are accurate, traceable to internationally agreed reference standards and performed using competently calibrated instruments.

Affordable and Clean Energy - Specialized standards published by the International Electrotechnical Commission IEC , the International Organization for Standards (ISO) and supportive accredited conformity assessment services provide invaluable and critical support for governments and organizations as they seek to enhance energy efficiency, economic performance and the transition to clean energy. They also prevent unsafe, unhealthy or environmentally harmful products from entering the marketplace.

Water and Sanitation - A QI provides the technical means so that water can reach more people and is safe for consumption. It also ensures that pollution is being controlled and that water efficiency is promoted. Metrology also helps to develop reliable and internationally comparable metrics for tracking the level of reserves, rates of extraction and quality of national water sources, as well as the calibration of water meters that guarantee conservation and sustainable use and consumption.

PROTECTING THE PLANET - Protecting and nurturing our environment is indispensable for people's well-being and human survival. The impact of human activity on the planet has reached dangerous levels, threatening the sustainability and management of natural resources and the protection of the biosphere. Life below water and on land is substantially influenced by human activity and while targeted actions for environmental protection and rehabilitation are important, their impact is limited. It is essential that a new integrated approach for economic development is adopted where environmental sustainability is a key priority.

Responsible Consumption and Production - QI institutions and services are indispensable in supporting the transition towards sustainable consumption and production patterns. Many good practices have evolved related to QI systems that support the SDGs whilst simultaneously underpinning trade. As part of driving change, the requirements for manufacturing products must be adapted to deal with current issues. Establishing an appropriate quality policy (QP) and QI system can substantially assist nations in driving the required change, whilst also positioning their economy to seize the opportunities available through the appropriate and holistic implementation of the SDGs.

1. WHY THIS PUBLICATION?

In September 2015, 193 Member States of the United Nations adopted a historic resolution committing themselves to the 2030 Agenda for Sustainable Development[1]. It contains 17 Sustainable Development Goals (SDGs) and 169 targets, that seek to build on the Millennium Development Goals (MDGs) that ended in 2015. The SDGs are ambitious, universal, applicable in both developed and developing countries, and transformational. Furthermore, they are aimed at balancing economic growth, social development and environmental protection.

The SDGs are the result of a long, intensive, consultative process, and are owned by various stakeholders, countries, civil society and international organizations, including the United Nations. The transition from the MDGs to the SDGs is a huge step forward in national commitments to fulfil the United Nations founding vision of peace, well-being, economic stability and the realization of human rights for all. The UN Charter, adopted in 1945, has human rights and dignity at its core. It covers all aspects of what then was termed 'social progress and better standards of life' and today is generally described as human development and human well-being.[2] The 2030 Agenda for the SDGs sets forth an integrated plan of action structured in four main parts, as shown in the figure below.

The implementation of the 2030 Agenda's vision of sustainable development requires an integrated approach. The SDGs[3] are indivisible in nature and call for collective action at all levels. They aim to address the challenges of our time, with an overarching imperative of leaving no one behind, and addressing inequalities and discrimination as a defining feature. For many developing countries, the 2030 Agenda was adopted at an opportune moment, as they were preparing long-term development plans and implementation strategies that could mainstream the SDGs.

The fulfilment of the SDGs requires a radical change of economic activities, social practices and human behaviour. National and regional QI institutions, and the metrology, standardization, accreditation, testing, inspection and certification services they provide and enable, can continue to play a fundamental role in supporting this transformation. The measurement and technical assessment of key indicators related to the transparent management of resources, including monitoring and reporting resources, are not easy tasks. Identifying the appropriate properties and variables regarding this broad set of issues, along with the appropriate measurement techniques and conformity assessment procedures is where the contributions of national and regional QI institutions make a difference. Establishing an appropriate quality policy (QP) and the associated quality infrastructure (QI) system can therefore substantially assist nations in driving the required change while also positioning their economy to seize the many opportunities available through appropriate and holistic implementation of the SDGs. The information and examples provided on the following pages are intended to help provide insights and examples of how a QI supports and underpins implementation of the SDGs that have been included.

[1] Transforming Our World: The 2030 Agenda for Sustainable Development (UN General Assembly resolution 70/1, 25 September 2015) or in short, the 2030 Agenda.

[2] The UN Charter's Article 55 encapsulates a vision of "higher standards of living, full employment, and conditions of economic and social progress and development; solutions of international economic, social, health and related problems; and universal respect for and observance of human rights and fundamental freedoms for all without distinction as to race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status." It aims to achieve the aspirations of the Universal Declaration of Human Rights of a world free from want and free from fear.

[3] The 2030 Agenda recognizes that the "SDGs and targets are integrated and indivisible, global in nature and universally applicable, taking into account different national realities, capacities and levels of development and respecting national policies and priorities."

Source: UN Development Group, 2015, "Mainstreaming the 2030 Agenda for Sustainable Development: Interim Reference Guide to UN Country Teams," p. 6.

2. QUALITY INFRASTRUCTURE (QI)

A quality infrastructure (QI) comprises the national and regional institutions responsible for metrology, standardization, accreditation and conformity assessment, related services and the relevant legal and regulatory frameworks. This technical infrastructure supports effective domestic markets, facilitates access to foreign markets, helps to promote and sustain economic development and social and environmental well-being.

QUALITY INFRASTRUCTURE

"The system comprising the organizations (public and private) together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the quality, safety and environmental soundness of goods, services and processes.

It relies on

» metrology,

» standardization,

» accreditation,

» conformity assessment, and

» market surveillance."

Source: INetQI

An effective national and / or regional QI provides many of the technical tools needed to determine and demonstrate compliance with the regulatory or customer requirements for the product or service under consideration. More specifically:

Metrology

Offering a product or service that is consistently high quality, therefore protecting health, safety, environment and consumer, makes accurate and consistent measurements and measuring equipment indispensable is the role of the science of measurement, known as metrology. Firms cannot satisfactorily implement process controls to manufacture a product or deliver a service that continually meets the required characteristics if instruments such as those for measuring pressure, volume of water flow or temperature are not properly calibrated. Measuring equipment used in laboratories needs to be periodically calibrated as part of the provision of test data that is reliable and repeatable.

A metrology system comprises legal, industrial and scientific metrology. To be credible, measurements must be traceable to existing international standards and satisfy the criteria of international comparability. International coordination and mutual recognition of countries´ measurement capabilities are facilitated through the global metrological system administered by the International Bureau of Weights and Measures (IBWM/BIPM) (scientific metrology) and the International Organization of Legal Metrology (OIML) (legal metrology). More information on both of these organizations is contained in "Annex A: International QI Organizations and Their Roles".

Standardization

Products and services should meet the expectations of those who use them and should perform as intended, be safe, easy and reliable to use. Standards translate these or any other characteristics desired by users or buyers into technical dimensions, tolerances, weights, processes, systems, best practice and other specifics so that products and services that conform to their requirements provide confidence to buyers and users. Standards are also developed to define the performance and other characteristics of processes, people, organizations and management systems.

The World Trade Organization on Technical Barriers to Trade (WTO/TBT) Agreement[4] defines *standard* as a voluntary document with which compliance is not mandatory - as opposed to a *technical regulation*, with which compliance is mandatory. The WTO/TBT definition has introduced a clear-cut distinction between standards (voluntary) and technical regulations (mandatory), which is very useful and has been broadly accepted in the field.

tional systems of standards are usually coordinated by a National Standards Body (NSB), which operates as the focal point and works with industry, government authorities and civil society to develop standards for usage at home. The NSB also represents a country´s interests at regional and international organizations that develop international consensus standards. More information on such organizations, e.g. the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU), is contained in "Annex A: International QI Organizations and Their Roles".

Accreditation

Providers of goods and services that use processes or procedures to determine whether these meet the requirements specified by laws and regulations, or those set by the standards which industry or other stakeholders develop, need to perform such work competently.

National and regional bodies exist that assess and accredit these organizations using the relevant criteria contained in international standards. By submitting to a peer evaluation of their operations, these accreditation bodies can obtain international recognition of their own competence for the types of accreditation they offer. If successful, they are then invited to join international and regional cooperation arrangements administered by the IAF and ILAC. More information on these two organizations is contained in "Annex A: International QI Organizations and Their Roles".

[4] World Trade Organization on Technical Barriers to Trade Agreement, Annex 1, para 2.

Conformity assessment

Conformity assessment (CA) refers to the processes and procedures that are used to demonstrate that a product or service, process, management system, or personnel meet specified requirements. CA services are performed by organizations that specialize in testing, inspection and certification.

» ***Testing.*** Testing a product or service or process against a specific set of criteria, such as performance or safety is the most common form of conformity assessment. Testing also provides support for other types of CA such as inspection and product and management system certification.

» ***Inspection.*** Products, services or processes may be inspected by bodies acting on behalf of governments and businesses. This helps reduce risk to the buyer, owner, user or consumer of the item relating to such parameters as quality, fitness for use or safety of operation. Inspection bodies are responsible for examining a wide range of domestically produced or imported products, materials, installations, plants, processes, work procedures and services in the private and the public sector.

» ***Certification.*** Certification is the formal assurance, provided by an independent third-party certification body, that a product, service, process, person, organization or management system conforms to specific requirements.

Organizations offering CA services may offer these on a commercial basis or they may be operated or mandated by the government. The CA activities themselves should follow the requirements contained in the appropriate international standards to ensure consistency worldwide and facilitate cross-border acceptance of results, making regional and international trade easier.

Market surveillance

Market surveillance refers to the activities of market surveillance authorities (usually under government responsibility) to verify whether products and services comply with applicable regulations. The purpose of these activities is to ensure products and services placed on the domestic market do not endanger health, safety, or the environment, and to strengthen trust among existing and potential clients. Market surveillance can also refer to activities which a manufacturer undertakes to proactively collect and review experiences gained from the use of their products in the marketplace. In this instance the purpose includes the identification of issues that may need corrective or preventive action.

1. Challenges related to developing appropriate QI capacity and capability

A QI system needs considerable financial and human resources and several years until it achieves recognition by other countries. Meeting safety and quality standards and demonstrating compliance cannot be achieved without incurring costs to both the public and private sector. Laboratory results can only be trusted if these are accurate and repeatable. When calibration and testing laboratories, auditors and certifiers, are not recognized by clients in foreign markets, local producers and suppliers often need to repeat compliance procedures for every foreign market. This is costly and can easily render them uncompetitive. This is true both for manufactured goods and agricultural products.

If a suitable and appropriately public funded national QI is not available or if it does not deliver acceptable results, local businesses need to procure such services elsewhere if they want to satisfy the needs of foreign customers. This can, and often does, effectively prevent these businesses from participating in international markets and obtaining the associated benefits. SMEs and other exporters from developing countries often find themselves in such a situation. Noncompliance can significantly affect the reputation of a producer or even worse, a country´s entire export sector can be tarnished and banned from accessing a foreign market.

Ideally all stakeholders should be able to rely on, and use, the same cohesively managed national QI system. Therefore, efforts should be concentrated on implementing and maintaining a single national system. It is also important that a QI is viewed as an interdependent system as when one component performs poorly, the usefulness of all other components can be compromised.

A QI that enjoys the support and acceptance of all stakeholders can meet the expectations of businesses and consumers related to quality and can also be used to satisfy regulatory needs. Regulators can incorporate standards that exist or are developed by the NSB in their regulations together with the use of accredited CA services as a means of enforcing technical regulations within their respective fields. It is important to note that the availability of QI capability does not replace the enforcement oversight responsibilities of a regulator. They would still need to periodically check products and packaging sold in stores, or conduct audits of production facilities to ensure ongoing compliance with the relevant regulations.

2. QI in support of the United Nations Sustainable Development Goals (SDGs)

Establishing an appropriate quality infrastructure (QI) can substantially assist a nation in positioning their economy to seize the many opportunities available through appropriate implementation of the SDGs. A QI covers essential aspects such as policy, institutions, service providers, and the value-adding use of international standards and conformity assessment procedures. It supports governmental policy objectives in areas including: industrial development; trade competitiveness in global markets; the efficient use of natural and human resources; food safety; health; the environment and climate change. All component parts of the QIS act synergistically with each other and provide a valuable tool for defining, developing and verifying quality requirements for products and services. The system components assist in the verification and demonstration that products and services actually meet specified requirements.

The institutions of and services provided by a QI can provide policymakers, businesses and other stakeholders with the technical knowledge and capacity to strengthen the implementation, measurement and monitoring of many of the goals and objectives contained in the SDGs, and support actions that promote them. Specific examples of the use of a QI in support of the various SDGs are contained in the chapters that follow.

3. The role of INetQI in promoting best practice

Responding to the challenges of globalization, trade and sustainable development, twelve international organizations have agreed to enhance their cooperation in promoting the understanding, value and acceptance of a QI and providing guidance and support for its effective implementation and integration worldwide as part of the International Network on Quality Infrastructure (INetQI).

These organizations are the:

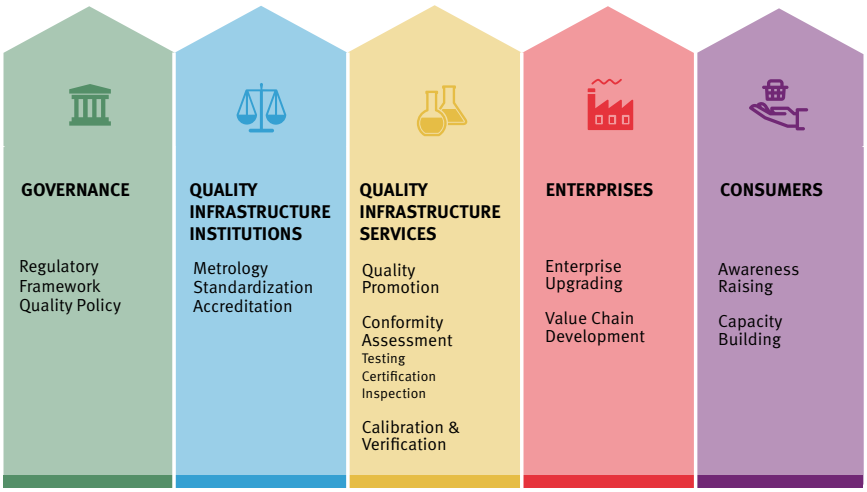
- International Bureau of Weights and Measures (IBWM/BIPM)
- International Organization of Legal Metrology (OIML)
- International Electrotechnical Commission (IEC)
- International Standards Organization (ISO)
- International Telecommunication Union (ITU)
- International Accreditation Forum (IAF)
- International Laboratory Accreditation Cooperation (ILAC)
- United Nations Industrial Development Organization (UNIDO)
- International Trade Centre (ITC)
- United Nations Economic Cooperation for Europe (UNECE)
- World Trade Organization (WTO)
- World Bank Group (WBG).

In recent years, the INetQI (formerly known as DCMAS) has collaborated in providing technical quality infrastructure training programmes (Poland 2014, Mozambique 2015) and in the development of diverse publications and guidance documents. In the framework of the network, a set of three documents were developed to support developing countries in the formulation of quality policies: guiding principles, technical guides and practical tools. The INetQI recently agreed on a new definition of QI (see box). The new definition expands its scope of action to globally promote the acceptance of a QI and is expected to create additional benefits for stakeholders including its use as a foundation for sustainable development. The renewed commitment of the network occurred after the international community, at the 26th meeting of General Conference on Weights and Measures, agreed to revise the International System of Units (ISI).

4. UNIDO'S Quality Infrastructure Development System

UNIDO has an extensive and proven track record in working with governments, industry and other major stakeholders to develop and strengthen national and regional QIs. Such programmes are one of the specialized services that UNIDO offers among its overall activities to promote inclusive and sustainable industrial development (ISID). Such an approach offers developing countries, and economies in transition, opportunities to eradicate poverty and develop sustainably. ISID also helps them to build their industrial base as a platform for social inclusiveness, economic competitiveness, environmental sustainability and integration with the global trading system. The institutions and services of a QI provide businesses, policymakers and other stakeholders with core knowledge about ways of doing things, paralleled with insight into the appropriate supportive tools.

As can be seen from the illustration, UNIDO's approach is holistic, from building awareness of QI to helping initiate, develop and strengthen a fit-for-purpose QI that runs efficiently and cost effectively. The approach emphasizes the need for strong collaboration and cooperation with all stakeholders to meet shared objectives through agreed activities that lead to concrete actions. Together with partners from the public and private sector, academia, national and international organizations in charge of standard-setting and global practices on metrology, standards and conformity assessment, UNIDO promotes good practices, capacity-building and training, and fosters global cooperation in standard-setting, measurement and compliance development along value chains.



3. SUSTAINABLE DEVELOPMENT FOR PEOPLE, PLANET AND PROSPERITY

Adopted by the United Nations on 25 September 2015, the 2030 Agenda for Sustainable Development sets an ambitious vision for the world and charts the course for how to achieve it. The 2030 Agenda comprises 17 interconnected and complementary Sustainable Development Goals (SDGs), that are a global call for action to protect the planet, ensure dignified lives for all people, and achieve inclusive economic growth, peace and prosperity. The SDGs are universal, provide a holistic approach to future development and are intended to provide guidance to both public and private actors everywhere in the world.

It is acknowledged that governments have the responsibility for setting the relevant national targets, adopting suitable policies and ensuring that the necessary actions are taken to meet them. Societal actors, including businesses and consumers, are also recognized as fundamental contributors to the successful attainment of these goals and targets. The SDGs present an opportunity for companies to align their strategies and business models with global sustainable development needs. Individuals are encouraged to actively contribute to the creation of a better world, also for future generations, by active engagement and action such as practicing sustainable consumption.

The SDGs, directly supported by the development of quality policy (QP) and the associated quality infrastructure (QI), can be grouped into three themes: Prosperity, People, and Planet. These are elaborated on briefly below, and in more detail, regarding the contribution of QI, in the body of the document.

Building Prosperity

SDG 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, and SDG 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, relate to economic development. These goals direct attention towards industry, innovation and infrastructure, and responsible consumption and production, decent work and economic growth that is no longer coupled with environmental degradation.

Meeting the Needs of People

SDG 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture, SDG 3 - Ensure healthy lives and promote well-being for all at all ages, SDG 7 - Ensure access to affordable, reliable, sustainable and modern energy for all, and SDG 6 - Ensure availability and sustainable management of water and sanitation for all, address societal issues. They include the call for the eradication of poverty and improvement of health. Such issues, and the other areas identified in these goals, are crucial elements of well-functioning societies.

Protecting the Planet

Protecting the biosphere is an essential precondition for everything, including economic development. There are 4 SDGs under this theme heading, namely ***SDG 13*** *– Take urgent action to combat climate change and its impacts, SDG 12 – Ensure sustainable consumption and production patterns, SDG 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development, and SDG 15 - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and biodiversity loss.* If these SDGs are not achieved, success in reaching all of the others is almost impossible. The activities related to the production, transportation, trade in, and consumption of goods and services both depend on and impact the biosphere. Negative impacts that these SDGs intend to mitigate against include the rapid depletion of finite natural resources, harmful emissions and toxic discharges.

The SDGs are deeply interconnected and mutually supportive by design. Economic activity and development are at the core of most human activity and are an essential driver for prosperity. At the same time, irresponsible economic activity is also responsible for unsustainable exploitation of finite natural resources. To preserve these for future generations, it is imperative that economic activity is aware of the negative consequences of a short-term focus that does not consider the total cost, negative impacts and unintended consequences for society as a whole. Economic activities must also address the growing demands for social protection including decent working conditions, which is very challenging and calls for radical change and innovative solutions. However, it also offers immense opportunities to those who are able to embrace and address these challenges. The 2017 report by the Business & Sustainable Development Commission[5] (BSDC) elaborates on the ways in which corporate practices and markets need to change. The report also highlights that such a transformation would unlock US$12 trillion of market opportunities for businesses and could create at least 380 million new jobs by 2030.

Since 2015, governments have begun to mainstream the SDGs and targets into national plans and many now report on their progress in this regard. These national plans detail programmes, projects, and related tasks. They specify the ministries and other stakeholders involved and detail the modalities of work. They also define metrics for measuring progress and mechanisms for overseeing, monitoring and evaluating what the country has achieved. UN agencies and other international organizations, donor governments, global civil society and the academic and scientific community are deploying a wide range of policy expertise, technical assistance, financial resources and knowledge sharing platforms to assist countries in the development and implementation of national plans and reporting mechanisms. More than 60 countries reported on their progress in implementation including specific challenges they encountered through voluntary national reviews[6] (VNRs) in 2016 and 2017.

Some of the issues that need to be considered in achieving the SDGs include:

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[5] Business & Sustainable Development Commission, Better Business Better World, 2017.

[6] UNDP, Available at: http://www.undp.org/content/undp/en/home/blog/2018/tracking-sdg-progress-is-a-team-effort.html

» Decision makers in the public and private sector need to take a holistic view during the design and implementation of a national sustainable development (SD) strategy. This includes a recognition that the economic, social and environmental aspects of sustainability are interrelated. Policymakers need to identify and exploit existing synergies while understanding that there will also be times where there needs to be an appropriate consideration and trade-off between pressing, often short-term, economic imperatives and financial needs versus the longer-term SDG aspirations and associated gains.

» Recognizing that SDG related issues are interconnected, and that having strong institutions with economic, social and environmental mandates is not enough. Public institutions with mandates that directly or indirectly contribute to, or are affected by, the SDGs must coordinate the implementation of related activities in close cooperation with the private sector organizations impacted by them. For example, environmental considerations should be appropriately reflected in policy decisions related to energy supply, and the promotion of industrial development and prosperity. Government policies or programmes that encourage production, and / or consumption with negative impacts on the natural environment should not be pursued as such impacts can easily negate the intended benefits of such development in the longer term.

» Ongoing national stakeholder engagement is critical. Decision-making must be inclusive, encourage the participation of all affected stakeholders in SDG issues, and consider their respective needs as well as their know-how. Participation should not be restricted solely to sharing information and should include active consultations and collaborative decision-making.

» Global cooperation and partnerships – both within and between economic sectors, across borders, at government-to-government level, and between non-state actors and the private sector – are critical if the intent of the SDGs is to be achieved within the stated time frames.

It is important that countries align their national SDG priorities with the current and planned national capabilities and resources available to ensure effective implementation. Among the requisite capabilities and resources is the development and maintenance of an appropriate national quality policy (NQP) and associated QI, as described throughout the rest of this document.

UNIDO has provided support to strengthen the Intra-African Metrology System (AFRIMETS) and its capacity to facilitate the trade of African products. This resulted in the Strategic Roadmap 2012 – 2016, which is a snapshot of scientific, industrial and legal metrology in Africa. The roadmap identified and analyzed gaps in measurements of standards and legal metrology and proposed a number of recommendations for the development of a sustainable continental metrology infrastructure. In 2014, a session of the AFRIMETS Legal Metrology School was organized in Tunisia. The Legal Metrology School was specially designed to introduce the basis and quality aspects of legal metrology to young African metrologists in the early stages of their careers, especially for those wishing to intensify and expand their knowledge on metrology, and in addition, contribute to their national and continental metrology department. 86 participants attended the school, including 15 women and 10 participants from Tunisia. They were trained on a range of topics including concepts of measurement, conformity assessment and quality aspects of legal metrology, amongst others. In addition, they were given practical training in industry through field visits to 8 Tunisian companies. The school gave participants a good grounding in theory, and hands-on experience on both practical and legal metrology.

See: http://www.acp-eu-tbt.org/imcustom/AFRIMETS_Results_v_1.13c_low_res.pdf


GOOD HEALTH & WELL-BEING
AFFORDABLE & CLEAN ENERGY
CLEAN WATER & SANITATION
FOOD & AGRICULTURE
INDUSTRY, INNOVATION & INFRASTRUCTURE
QUALITY INFRASTRUCTURE
CLIMATE ACTION
DECENT WORK &ECONOMIC GROWTH
LIFE ON LAND & BELOW WATER
RESPONSIBLE CONSUMPTION & PRODUCTION

4. BUILDING PROSPERITY

4.1 Industry, Innovation and Infrastructure

SDG 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

SDG 9 mainstreams poverty eradication and inclusiveness to build productive capacities in an inclusive manner. It also provides more opportunities for all women and men as well as across social groups, also through partnerships with all stakeholders involved in industrialization processes. It is intended to promote rapid economic and industrial growth, build trade capacities in industries, and ensure that all countries can benefit from international trade and technological progress, as well as through the application of modern industrial policies and compliance with global standards and norms. It aims to advance environmentally sustainable growth, build institutional capacities for greening industries through cleaner production technologies and resource efficiency methodologies, and create green industries, spurred by technology facilitation, innovation and partnership building.

1 Inclusive and Sustainable Industrial Development (ISID) and Innovation

To a significant extent prosperity is related to economic development which, in turn, is deeply influenced by the development of industry and infrastructure. Industrialization has become one of the most dynamic drivers of sustained growth and sustainable development. Industrial competitiveness and innovation are also key to successfully and sustainably accessing the global marketplace with the intention of enhancing prosperity and securing greater collective well-being. The economic success of nations is therefore inextricably linked to their ability to manufacture and trade precisely made and tested products and components that are accepted by trading partners and meet destination market regulatory and consumer requirements. Manufacturers need to ensure products are of consistent quality, comply with relevant regulations and standards, and meet the necessary requirements and specifications. It is recognized that manufacturing has historically been a key driver for economic growth in the development of many countries and can therefore be considered as an important engine for growth.

Another important requirement for sustained economic growth in today's knowledge-based economies, which rely ever more on intangible resources, is innovation. The Organization for Economic Cooperation and Development (OECD) defines innovation[7] as "the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." Innovation is widely recognized as one of the essential drivers of a successful business and a key contributor to a nation's productivity and economic and social development.

In his foreword to the UNIDO publication "Structural Change for Inclusive and Sustainable Industrial Development (2017), The Director General of UNIDO, LI Yong, states that "Successful development of labour-intensive industries sets the foundation for industrialization, as increased exports, revenues and consumption boost investments in education, infrastructure, and research and development." He goes on to note that "The successful shift of the industrial structure from labour-intensive to capital-intensive industries increases productivity and generates higher wage jobs, which could help sustain industrial growth and lead to the creation of shared prosperity."

It may concern product improvements (higher quality, more and superior functions, new products), process improvement (achieved through automation, new organizational models and methods), service improvement (better customer service, maintenance, new ways of managing information and transactions), or marketing improvements (how to reach and communicate with existing and potential customers, approaches to reward customers, and mechanisms to increase the transformation of leads in sales). Encouraging innovation is an important issue for both forward-thinking companies and governments.

The new ISO 56000 series of international standards is aimed at providing organizations with guidelines and processes that enable them to get the most out of their innovation projects. ISO/FDIS 56002, currently under development, provides guidance for an innovation management system. ISO 56003, "Innovation management – Tools and methods for innovation partnership – Guidance", provides a structured approach for organizations looking to enter into an innovation partnership with another organization.

In many countries there is a strong focus on the public funding of research and development and on intellectual property rights (IPR) as instruments of innovation policy and business strategy.

In Spain, the national tax authorities, as well as individual companies, needed a reliable and trusted information system to allow them to demonstrate the innovative component of projects and activities. The resultant system, based on accredited certification activities, has enabled a climate of confidence and greater certainty for companies seeking to make research, development and innovation-related investment decisions. It is also used by the tax authorities to assess the associated tax reductions that are available in terms of government policies for the promotion of research, development and innovation.

[7] Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, OECD, 2005.

2 Challenges and the Achievement of Transformational Needs through the SDGs

Industrialization and infrastructure development in the 21st century must address issues within a radically different context than previous eras. In comparison to the beginning of the 20th century, the world population has increased more than 3 times (from less than 2 billion to over 7 billion people); the biosphere has dramatically altered; non-renewable resources, once abundant and cheap, are now increasingly difficult to obtain and more expensive; waste and pollution, previously considered almost a negligible problem, are now major concerns. Climate change, which previously was not considered in previous growth strategies, is now a global, and increasing challenge. Humanity is ever increasingly pressing against some previously unconsidered boundaries and this has enormous implications on how industrialization and infrastructure development should now be pursued.

> "An increase in CO2 emissions and material use was registered in the manufacturing sectors across all country groups, largely driven by the effects of increased volumes of production. This occurred despite the positive trend in the reduction in environmental intensity (environmental impact per unit of output) of production across all country groups, except for low-income economies."
>
> "Efforts to reduce environmental intensity further still must be accelerated and the relevant technology defused as widely as possible."
>
> Structural Change for Inclusive and Sustainable Industrial Development, UNIDO (2017).

Regarding the pursuit of inclusive and sustainable industrial development (ISID), there are some fundamental issues that need to be considered:

- Industrial and infrastructure development has a long-term impact which can lead to major unintended consequences depending on the strategies adopted and choices made. Power generation plants based on fossil fuels, inefficient manufacturing plants that generate pollution, transportation based on the use of internal combustion engines coupled with rapid and chaotic urbanization patterns can easily create unsustainable conditions that will not be easily or cost effectively remedied.
- The damage caused during indiscriminate extraction of natural resources is often irreversible, e.g. deforestation dramatically increases CO2 emissions, unsustainable agricultural techniques cause soil degradation, contamination of surface water and inappropriate irrigation techniques and water policies can substantially increase the water stress of vulnerable countries.
- Metropolitan and industrial waste, if poorly planned and managed, can result in catastrophic consequences on human health and environmental degradation.
- Economic growth, if not balanced by appropriate government and societal action, may trigger exploitation of workers, sub-standard health and safety measures, disruption of communities and corruption, leading to increased income inequality and deep fractures within societies.

These aspects are amongst those that need to be carefully considered by policy makers and industry leaders engaged in the development of sustainable industry and infrastructure.

> One of the functions of municipal governments in Ecuador is to regulate, prevent and control environmental pollution. To comply with these guidelines, the Metropolitan District of Quito developed an ordinance that establishes mechanisms of control to verify compliance with environmental regulations for the monitoring of the compliance within permissible limits of discharge, emissions of air contaminants and waste generated by industries. To prove compliance, the sampling and analysis of liquid effluents, air emissions, solid wastes and noise are performed by accredited laboratories.

3 The Role and Application of QI

The disciplines, organizations, practices and policies that collectively constitute what today is known as QI have been fundamental in enabling and supporting the development of industry and, in particular, manufacturing. Metrology, standardization and the assessment of conformity to requirements and specifications have evolved in step with the Industrial Revolution that originated in Europe in the nineteenth century. In traditional artisanal practice predating the industrial revolution[8], highly skilled craftsmen would make and assemble every part of a finished product. This is still the practice adopted in many societies that have not been impacted by industrialization.

A critical change occurred in manufacturing during the Industrial Revolution. The use of lathes and other such machine tools enabled the production of high precision, mass reproduced and interchangeable component parts. This advance occurred in parallel with, and relied on, other important developments such as the harnessing of steam power in production and transport and improvements in mining and metallurgy. Higher productivity and quality were also achieved by the appropriate division of labour, and together these dramatically changed the economic landscape. Such developments would have not been possible without objective, reliable, precise and agreed measurement techniques and instruments, along with agreed standards for dimensions, tolerances, performances

[8] There are historically outstanding examples of mass-production based on interchangeable parts prior to the Industrial Revolution (e.g. the terracotta army of Chinese emperor Qin Shi Huang around 200 BC, or ship building in the Arsenal of Venice, Italy, in the sixteenth century) but these can be considered remarkable exceptions.

and quality control. A broad set of challenges had to be addressed by the emerging QI supporting industrialization. These included the determination of product characteristics, quality and suitability of materials and parts, compatibility / usability issues, safety and fitness-for-purpose of end products. This led to the need to address issues regarding calibration of instruments, testing of material and other assessments of compliance with requirements and standards (i.e. what is now known as conformity assessment practices).

It took decades of effort and international cooperation to establish this infrastructure which has subsequently expanded from an initial focus on materials, parts and products, to cover processes, services, health, safety and environmental protection requirements.

The worst maritime disaster in the history of the United States was the sinking of Mississippi's side-wheeler Sultana's in 1865 (with a death toll estimated between 1,200 and 1,500 people) caused by the explosion of three of her four boilers. According to Batik "in 1884, approximately 10 000 boiler explosions and failures occurred in the US - property damage, fatalities and injuries must have been terrible. In contrast, during the period 1974 to 1984, there wasn't a single boiler explosion in the United States." The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BSVC) had a primary role in spreading safe design practice and manufacturing criteria (along with regulatory requirements) which substantially improved boiler and pressure vessel's performance and safety.

Quality products and their associated production systems rely on the availability of appropriately accurate measurements for a wide range of parameters. The successful fulfilment of this ever-increasing need is characterized by the ability to provide a national or regional QI – metrology, standards and accreditation - to support effective conformity assessment (CA) services - calibration, testing, inspection and certification. In appropriate combination, these can help ensure that components and finished products meet the regulatory requirements and quality expectations of consumers including those contained in documentary standards and specifications.

The critical function that national and regional quality infrastructures have in enabling and supporting industrialization and the inherent complexity of the challenge for developing countries should be self-evident. It is possible to gain valuable insights from the experience of more advanced industrialized countries, and a wealth of international standards and good practices are available. Developing countries also have access to the support provided by development agencies, such as UNIDO, that can provide specific and tailored QI technical assistance and capacity building interventions. This is important when considering that they are under pressure to develop appropriate and capable QI institutions and services in a fraction of the time taken by the more developed countries.

The IEC publishes more than 9000 consensus-based international standards that cover all devices and systems that generate or use electricity and contain electronics. The IEC also manages four conformity assessment systems that are internationally trusted mechanisms to help verify the safety and efficiency of electric and electronic systems and devices. The IEC Affiliate Country Programme offers developing countries around the world a unique form of participation without the financial burden of actual membership.

4 The Way Forward

QI institutions and services have a fundamental role for industry and infrastructure. They need to evolve under the guidance of a national quality policy (NQP) to better support the development of sustainable industry and infrastructure. Some specific areas where an appropriately developed national or regional QI could and should play an important role, include:

- The development of metrology, standards and CA procedures to assess and improve the ecological performance of materials and products and support the energy efficiency of products and systems, including:
  - The determination of the environmental footprint of materials and products (based on lifecycle assessment and other aspects), and the definition of indicators and standardized rules for different categories of materials/ products.
  - The ecological design of products supporting modularity, re-use of product components and re-cycling of materials, and the optimization of use of materials and energy over the product lifecycle.
  - The energy efficiency of buildings, industrial plants, vehicles, electrical appliances, etc.
- Metrology and other standards, accreditation, capability and CA procedures for testing, inspection and certification to embed sustainability requirements within projects (including infrastructure projects).
- Metrology and other standards, accreditation, capability and CA procedures for the testing, inspection and certification capabilities required to support the sustainable management of organizations, global supply chains, and associated environmental and social responsibility aspects.

The development of sustainable industry and infrastructure will need to be supported by appropriate

public policies, including an NQP, that promote and support aspects such as:

» Embedding core sustainability criteria into future plans for economic development. This should specifically include the building of new / extension of existing infrastructure, urban planning, and industrial development.

» Appropriately and consistently utilizing public procurement as a mechanism to promote and support technologies, solutions and behaviours that encourage the development of sustainable industry and infrastructure.

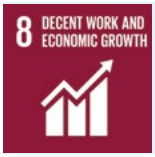
» Embedding well-defined sustainability criteria, indicators and targets into the design and implementation of public-private sector partnerships.

» Seeking financial support for sustainable infrastructure and similar projects from multilateral development banks, such as the World Bank, and other financial institutions who are increasingly active in this area.

» Designing and applying social policies that aim to protect workers, sustain the poor and mitigate inequalities.

UNIDO worked with Zambian authorities to develop and implement a national quality policy (NQP) to ensure that Zambian goods and services were designed, produced and supplied to meet the requirements of purchasers and consumers in local and export markets, and satisfy their regulatory authorities. The NQP assisted the Ministry of Commerce, Trade and Industry (MCTI) to review the overall organizational framework for the national quality infrastructure, including related legislation, and helped to establish a credible conformity assessment infrastructure. The facilities of the Zambian Bureau of Standards (ZABs), the Zambia Weights and Measures Agency (ZWMA) and the Food and Drug Control Laboratory (FDA) were upgraded with a specific focus on improving the food sector's ability to prove conformity. The development of the NQP enabled Zambia to build its production capacity and demonstrate compliance of its products with international standards, leading to better integration into the multilateral trading system.

4.2 Decent Work and Economic Growth



SDG 8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

SDG 8 facilitates structural transformation and economic growth by increasing the capacities of local industries for value addition, economic diversification, and export promotion, as well as supports the creation of decent jobs in industry and industry-related services.

The health and safety of citizens and workers is an important contributor to sustainable development. Impacts on the SDGs include eradicating poverty through job creation, sustainable livelihoods, technology and skills development, food security and equitable growth, ensuring sustainable consumption and production and health and safety in the workplace. Businesses therefore encounter increasing social, commercial and regulatory pressures to assess and control hazards and risks from their operations. In addition to addressing health and safety issues, there is also the need to promote more transparency in trading. An appropriate QI can ensure for instance that a farmer receives an equitable payment for their produce, and that all consumers receive the correct amount of goods for their money. The control of prepacked goods also helps to reduce fraud in this increasingly important area, often involving staple foodstuffs. The correct measurement of raw materials exported in bulk can also ensure that not only is the correct price paid, but that the government is able to collect the correct tax for exports.

1. Economic Growth through Trade

The 2030 Agenda for Sustainable Development recognizes international trade as an engine for economic growth and poverty reduction, and an important means to achieve the Sustainable Development Goals (SDGs). According to research by the World Trade Organization and the World Bank[9], "the expansion of international trade has been essential to development and poverty reduction". They note that trade as a proportion of global GDP has nearly doubled in the last 40 years, which can be attributed to the globalization of markets for goods and services and increased integration due to a reduction in trade barriers, and innovations in technology that are assisting in driving down the costs of trade. There is also an increasing awareness of the need to transform the multilateral trading system to make it structurally "inclusive and sustainable". However, this is a non-trivial issue because while there may be few doubts on the role of trade as an engine for growth, there are serious concerns about the relationship between trade and sustainability. Some historic trade practices have already been proven to be a significant amplifier in the depletion of natural resources, increased pollution and the adoption of practices that can cause environmental and social harm. Industries, utilities and other organizations supplying goods and services, together with government as a procurement agency, therefore need access to appropriate technologies in order to reduce water consumption, energy inputs and reduce CO_2 emissions, air and soil pollution, and better manage solid and wastewater. Trade can be used as a vehicle to reduce the negative consequences of increased

[9] World Bank Group and World Trade Organization, The Role of Trade in Ending Poverty. World Trade Organization: Geneva, 2015.

economic activity by making such technologies more easily available.

The World Trade Organization and the World Bank caution that "trade is not an end in itself"[10]. To achieve the intended outcomes related to the SDGs, including SDG 8, the value of increased trade needs to be measured by "the extent to which it delivers better livelihoods, through higher incomes, greater choice, and a more sustainable future". The same report stresses that sustained efforts will be required to continue to strengthen and deepen economic integration to achieve the further reductions in trade costs coupled with the strong growth required in developing countries that is essential to end poverty. They note that "trade is a critical enabler of such growth" given its potential for creating new opportunities for new and better work for the poor. The ability to sustainably and reliably access foreign markets can encourage businesses to increase production capacity and capability and achieve greater economies of scale that domestic markets alone normally do not provide. Exporters in a domestic economy have been consistently found to outperform non-exporters on a variety of measures of success, including productivity and profitability.[11]

Participation in GVCs can assist businesses to increase their knowledge and access better technology. Increased exports can translate to more opportunities for employment. At the country level, being open to trade tends to reduce poverty as financial sectors grow deeper, education levels increase, and institutions become stronger.[12] Although GVCs present opportunities for developing countries, the WTO[13] has found that they also face many barriers when seeking to integrate into them, such as infrastructure and customs barriers. A survey conducted by the WTO and the Organisation for Economic Co-operation and Development (OECD) in 2013[14] identifies the main barriers that developing country firms perceived as hindering their participation in GVCs. The survey highlighted inadequate infrastructure and standards compliance as obstacles. The report also noted that GVC participation was greater in countries with higher indexes for quality of infrastructure and institutions.

2. Challenges and the Achievement of Transformational Needs through the SDGs

While international trade has provided benefits to countries, there is little doubt that the rapid increase in the scale of global economic activity, including increased trade, is demonstrably contributing to the environmental degradation that the SDGs are intended to address. The production of goods and services, subsequent trade, consumption and ultimate disposal has an inherent cost to the environment that is rarely included in the price paid.[15] Part of the solution are effective environmental policies that deal with the problem at the source (production, consumption), while linkages with appropriate labour standards and proper enforcement can also help to create decent working conditions.

Trade assists by providing the economic incentives to companies to use the latest knowledge, technologies and good practices which reduce the impact of products and the production processes on the environment. These incentives can also encourage the better use of raw materials and water, and lower energy consumption when participating in GVCs, especially in countries that currently do not have a strong local technology capability. A recent WTO report [16]concluded that because trade has so many crosscutting effects within an economy and its diverse sectors, it is important that governments mainstream their trade policies into their national development strategies and plans. In continuing to work to lower barriers to trade, trade policies also need to be suitably aligned with the national SDG objectives. In addition, it is important to encourage greater connectivity between government trade and environmental cooperation at the international level.

3. The Role of QI in Supporting Trade

International trade requires that transactions take place between countries, often with different regulatory traditions and regimes. Through their linkages with international institutions and associated networks of cooperation, a national or regional QI provides some of the necessary tools to ensure that differences in national standards and technical regulations do not unduly restrict international trade. The following practical but simple scenarios highlight the things that a company wishing to access the market with a product or service is often required to do:

» A company wanting to sell to domestic clients needs to ensure that its products or services meet national legal or regulatory requirements that protect consumers or users against health and safety risks. Local buyers may also have additional specified or unspecified quality requirements.

» In order to access foreign markets, administrative and technical demands on the company can quickly escalate in complexity and associated resource needs. Foreign laws and regulations need to be understood and complied with. These can, and often do, vary significantly from one target market to another. There are also often additional quality-related requirements from the foreign customer, together with the need to provide tangible

[10] Ibid.

[11] For relevant studies see e.g., Aw and Hwang, Productivity and the Export Market: A Firm Level Analysis, Journal of Development Economics, Vol. 42(2), August 1995, pp.313-332, J. van Biesebroeck, Exporting Raises Productivity in Sub-Saharan African Manufacturing Plants, NBER working Paper, No W10020, October 2003.

[12] World Bank, Singh and Le Goff, Does Trade Reduce Poverty? A view from Africa.

[13] World Trade Organization, World Trade Report 2014, Trade and development: recent trends and the role of the WTO. World Trade Organization: Geneva.

[14] The Organisation for Economic Co-operation and Development (OECD) and World Trade Organization (WTO), 2013. Aid for Trade at a Glance: Connecting to Value Chains, Paris, Geneva: OECD, WTO.

[15] OECD, Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading, Paris, 2018.

[16] WTO, Mainstreaming trade to attain the sustainable development goals, Geneva, 2018.

and trusted evidence of compliance to these requirements. As stated in the previous section, this is even more so where food and other agricultural products are concerned, given that strict sanitary and phytosanitary (SPS) rules often apply.

It is important to note that these two simple scenarios do not address the upstream value chain management and control requirements that are necessary for a company to ensure that its products or services continuously meet customer expectations and regulatory requirements.

Table 1 provides an overview of key contributions expected from national and regional quality infrastructures in support of greater foreign market access while also encouraging a healthy and safe domestic market.

The WTO Agreement on Technical Barriers to Trade (TBT) acknowledges the role of regulations, standards, and conformity assessment (CA) procedures e.g. testing, inspection and certification, for the efficient attainment of public goals, and sets rules to ensure that these measures are prepared, adopted and applied in ways that do not create unnecessary barriers to international trade. Although the TBT is primarily about technical regulations, international standards (which are voluntary by definition in the TBT) are also considered as a basis for regulations (whenever they exist, or their completion is imminent). Regulations based on such internationally harmonized standards are therefore deemed not to constitute as a barrier to trade. The agreement requires that its members use international standards and

TABLE 1: AN OVERVIEW OF KEY CONTRIBUTIONS EXPECTED FROM A NATIONAL AND REGIONAL QI

Context	Contribution of Quality Infrastructure
Market access: access to export markets (for final products or self-standing product components)	» Ensure accuracy and comparability of results (traceability of measurement units and calibration of instruments; availability of test labs at a reasonable distance and affordable costs) » Support continual improvement of exporters' products and processes » Provide up-to-date and reliable information to exporters re: target markets » Enable exporters to achieve compliance with regulations (mandatory requirements) of target markets » Help exporters to meet expectations (quality requirements) of target markets
Market access: participation in global value chains	» Ensure accuracy and comparability of results (as before) » Support domestic participants to integrate in more complex production systems, requiring: » harmonization of processes, materials and instruments; as well as of tools and methods used in R&D and production, with those of the other participants in the chain (and notably the lead buyers) » Help domestic participants to build trust with the other participants in the chain, concerning: » reliability of the legal and technical infrastructure within which they operate » demonstration of compliance with international standards and other standards or proprietary requirements set by buyers
Domestic market: consumer and environment protection	» Ability to measure the properties and impact of materials and products, in particular those related to health and safety aspects » Ability to measure the environmental impact of production processes, products and services » Ability to set suitable technical regulations (and/or to support the adoption and use of voluntary standards, whenever appropriate) » Support the enforcement of technical regulations in a cost-effective way (for all parties) » Protect consumers and domestic producers (especially SMEs) from illegal or unethical practices adopted by foreign companies entering the market

relevant international guides or recommendations for conformity assessment procedures as a basis for:

» New or modified technical regulations

» Entering into negotiations for the conclusion of agreements for mutual recognition of results of each other's CA procedures

» Formulating and adopting international systems for conformity assessment

The agreement specifies a "code of good practice" which members must also implement in the preparation, adoption and application of standards. Regarding the increasing linkages between trade and SPS-related issues, it is also important to note a growing realization that the QI systems that were historically developed to address trade-related needs are very similar to those required to address sanitary and phyto sanitary (SPS) measures, and more recently the WTO Trade Facilitation Agreement (TFA) issues, especially in developing countries.

National standards bodies (NSBs) and related QI organizations collaborate on a national, regional and international level through dedicated fora and institutions to maintain and develop the technical infrastructure required to address TBT and SPS issues. Such activity includes the development and promotion of practical tools for use by their governments, industry and commerce to ensure that non-compliant WTO TBT trade practices and procedures are avoided. When cooperating on regulatory matters consistent with WTO rules, governments can make appropriate use of these tools, for example when concluding mutual recognition agreements (MRAs) or entering into economic partnership agreements (EPAs).

3.1 Government Mutual Recognition Agreements (MRAs)

The actions which governments can take to facilitate trade in line with the rules and recommendations of the TBT Agreement include the development of formal government-to-government mutual recognition agreements (MRAs). An MRA is a binding agreement under which one country, or trading block (A) agrees to recognize certificates issued by designated bodies in a second country or trading block (B) as a basis of compliance with its own (i.e., country A) regulations related to conformity assessment. The impact of such agreements can be significant. For example, a manufacturer located in country B and exporting to country A can arrange that all testing, conformity and certification of his product is undertaken in his home country, with the certainty that the relevant test and inspection reports certificates will be recognized by the regulatory authorities in the export destination of country A.

Each of these MRAs, if underpinned by the appropriate use of recognized components of a QI, including accredited conformity assessment, can also make a substantial contribution towards achieving the goal of "one test, accepted everywhere" and making it easier for businesses to access and sell to customers in many other parts of the world. Although many sectoral MRAs exist, very few are multi-sectoral in scope. Agreements of this kind currently appear to be limited to the EU and its major trading partners, Australia and New Zealand, Canada and the USA. Experience with negotiating these agreements has shown that strong political direction, close involvement of the regulatory authorities directly responsible to the public, and trust in the adequacy of conformity assessment procedures are essential for successfully developing and negotiating these MRAs. An established and trusted QI provides valuable support for such negotiations. The adequacy of the associated QI operational infrastructure and CA services need to be recognized by all parties involved as an essential element for government to explore and sign such MRAs.

3.2 Regional Cooperation

Despite tariff free access for most of their products to developed country markets, the share of the least developed countries in international trade remains relatively small. One reason is a lack of infrastructure, facilities and expertise to ensure that the quality of their products comply with the requirements of more developed markets. Countries therefore need to prioritize, invest in and appropriately improve their national quality infrastructure and a lot of cooperation aimed at facilitating trade is now occurring at regional level.

Regional trade agreements (RTAs) encourage participating member countries to consider what is needed both individually and corporately to ensure effective implementation of these agreements and can create new possibilities for increasing trade cooperation and advancing the achievement of the SDG goals. Such agreements can also provide strong incentives to improve, strengthen and modernize the associated national QI to fully benefit from these agreements.

As tariffs and other trade barriers reduce, the establishment of appropriate, equivalent and trusted QI capabilities helps to create a level playing field for all businesses in the region to compete. The processes involved can be illustrated by considering one of the QI-related organizations that the Asia Pacific Economic Cooperation (APEC) has developed to promote improvements in QI throughout that region. The Asia Pacific Laboratory Accreditation Cooperation (APLAC), a recognized region of ILAC, is a forum where nationally recognized accreditation bodies cooperate to harmonize accreditation practices and facilitate mutual recognition of accredited tests, measurements and inspection results. The APLAC Mutual recognition Agreement (MRA) also reduces the need for the re-testing of products.

In the context of the Quality Infrastructure Programme for Central Africa (PIQAC), a harmonized strategy of standardization and quality policy was implemented in the Central African sub-region, with the adoption of regulation texts by the Economic and Monetary Community of Central African States (CEMAC). These texts were approved by 18 ministers representing the six member states of the Economic Union of Central Africa (UEA), namely Cameroon, the Central African Republic, Chad, the Republic of Congo, Equatorial Guinea and Gabon. The programme is creating a favorable business environment, while assuring the conformity to international trade regulation laws and technical standards.

Another feature of many RTAs is that the parties involved pledge to closely cooperate on CA issues, including the sharing of information. Agreements involving the European Union (EU) seek to promote the adoption of, or alignment with, their harmonized community standards. In many RTAs, the parties agree to pursue mutual recognition agreements (MRAs), which for example APEC countries have used to better integrate their markets for telecom equipment and electrical and electronic products. Regional cooperations may also agree to share the costs involved in establishing QI institutions by developing regional bodies with mandates related to standardization or accreditation. There can also be arrangements for the sharing of testing and certification services. Such initiatives can assist countries to cost effectively and sustainably address their needs related to standardization, metrology, accreditation and other QI capabilities.

Another inherent benefit is greater coherence between the national and regional policies, more efficient use of limited resources, joint capacity building and joint trade and value chain strategies. Appropriate cooperation through regional bodies can help facilitate the development of common positions that can be subsequently used to appropriately influence QI-related harmonization activities at the international level.

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. 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 contaminates 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.

4. The Way Forward

The International Organization of Legal Metrology (OIML) administers a certificate system for measuring instruments to facilitate administrative procedures and lower the costs associated with the international trade of measuring instruments subject to legal requirements. The system provides the possibility for a manufacturer to obtain an OIML certificate and a test report indicating that a given instrument type (pattern) complies with the requirements of the relevant OIML international recommendations. Certificates are delivered by OIML member states that have established one or several issuing authorities responsible for processing applications by manufacturers wishing to have their instrument types (patterns) certified. OIML certificates are accepted by national metrology services on a voluntary basis, and as the climate for mutual confidence and recognition of test results develops between OIML members, the system serves to simplify the type (pattern) of approval process for manufacturers and metrology authorities by eliminating costly duplications of application and test procedures. More information about the system is contained in the document "Certification of Measuring Instruments" published by UNIDO and OIML and available at:

https://www.unido.org/sites/default/files/files/2019-05/OIML_online.pdf.

International trade is not only an essential component of a developing country's path to prosperity but can also be used to achieve many, if not all, of the outcomes related to SDG8. A suitable and sustainable national and regional QI provides fundamental enablers to support country aspirations related to, and participation in, international trade.

The achievement of such infrastructure requires a significant and continuous effort by developing countries (individually and in concert with their regional partner states) to initiate, develop, strengthen and coordinate the development needs and service offerings of their constituent QI institutions. However, continuing to direct QI capacity building efforts to exclusively address

export-related needs would be a fundamental mistake.

Given the fundamental role that a better coordinated QI can also play in appropriately accelerating the development of domestic markets while targeting the well-being of citizens and the preservation of a country's resources and assets over the longer term. In this regard, it is important to stress that the future development of national and regional QI capacity and capability needs to be geared towards ensuring:

The Trans-Pacific Partnership (TPP) is a trade agreement between twelve Pacific Rim countries - Mexico, New Zealand, Australia, Brunei, Chile, Singapore, Canada, Japan, Malaysia, Peru, Vietnam and the USA – that promotes economic growth through supporting the creation and retention of jobs and promoting productivity and competitiveness in order to raise living standards and enhance labour and environmental protection. In this partnership, accreditation and the use of existing regional and international mutual recognition arrangements has been referenced as a key measure to support trade through the removal of technical barriers.

- The protection of public health and safety from sub-standard products, hazardous substances and foreign pests. This should be seen as a top priority given that any gaps in these areas are likely to generate huge, and preventable, negative long-term impacts and related restorative costs.
- A focus on preventing both export and import trade of illegal goods.
- The effective support of a country's rights, including the collection and use of sound scientific evidence and impact assessment of policies, through the introduction of regulations effectively protecting citizens and the environment – especially when the pursuit of more effective domestic remedies requires confrontation with, and / or lobbying of, more developed countries and regions at fora, such as the WTO.
- Appropriate focus on, and support to, the development of more sustainable infrastructure and industry.
- Considered assessment of the legitimacy, impact and compliance-related needs of voluntary sustainability standards and similar private sector mechanisms, prior to deciding whether to grant government support to them.
- Targeted and impactful participation in international standards-setting and other QI-related organizations to ensure that the QI areas related to identified national priorities are adequately covered and appropriately monitored.

UNIDO provided support to Myanmar, where the national quality infrastructure was underdeveloped and lacked the capacity required for a modern economy with food supply chains integrated into global food supply chains. The existing capacity of four key testing food laboratories was strengthened, and training was provided to meet the requirements for accreditation to ISO 17025 (general requirements for the competence of testing and calibration laboratories) for some key testing parameters. The Myanmar Food Processors and Exporters Association (MFPEA)'s Food Industries Development Supporting Laboratory (FIDSL) received the bulk of support in terms of equipment, as its mandate is to provide testing services to MFPEA members and it is in the best position to rapidly extend its range of testing services to exporters with support from the project. The food inspection procedures and testing abilities of the Food and Drug Administration (FDA) and the Myanmar Inspection and Testing Services Ltd. (MITS) were also being improved with the aim of supporting them towards accreditation and enhancing consumer safety.

See: https://open.unido.org/api/documents/3264148/download/Factsheet_Myanmar.pdf and https://open.unido.org/projects/MM/projects/120027

5. MEETING THE NEEDS OF PEOPLE

5.1 Food and Agriculture

SDG 2 – End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

SDG 2 supports value addition to agricultural output and helps reduce post-harvest losses and increase resource efficiency, while generating job opportunities for rural communities and increasing food security, food safety and nutrition, particularly through agribusiness development and upgrading agro-food value chains.

1. Food, Agriculture and Economic Growth

The ability to manage plant and animal species for human benefit gave rise to agricultural economies that in time supported the development of urban centers and the establishment of complex, highly organized societies. The rise and fall of civilizations[17] have been indissolubly linked with their ability to master agriculture and maintain a sustainable interaction with the surrounding ecosystems. Agricultural techniques, including the introduction of new crop varieties, various forms of irrigation, crop rotation and the use of agricultural equipment based on human or animal force, have evolved over the centuries in various regions of the world. The perfection of crop rotation and selective breeding led to a radical transformation of agriculture driven by the Industrial Revolution during the 19th century. The subsequent history of agriculture has largely paralleled that of industrial development, the "mechanization" or "industrialization" of agriculture forming the basis of modern agriculture. Another contributing factor, the science of plant nutrition, was established through the work of German chemist Justus von Liebig and several others. As a result, by the end of the 19th century chemical companies started to produce synthetic fertilizers, which have been extensively and increasingly used ever since. The increasing usage of pesticides is also important, given that synthetic pesticides are now prevalent since their introduction during the 1950s.

The industrialization of agriculture supported a profound transformation of economies and societies. The phenomenal increase in agricultural output and productivity due to these advances allowed countries to achieve greater food security with a smaller workforce in just a few decades. The resultant spare capacity was then available for further developing and expanding industry, and this trend is still evident. The workforce occupied in agriculture in industrialized economies has continued to decline together with the share of gross domestic product (GDP) contributed by agriculture. The increases in agricultural output, combined with industrialization and the development of suitable transportation infrastructure, has enabled the development of the modern food industry. The delivery of fresh food, and associated processing, packaging and distribution, to consumers often located in other parts of the world is now accepted as normal.

[17] See e.g. Jared Diamonds Collapse: How Societies Choose to Fail or Succeed – 2005

2. Challenges and the Achievement of Transformational Needs through the SDGs

Agribusiness and the global food industry have evolved into very complex and highly regulated fields, comprising of interconnected systems of legislation, international collaboration and voluntary measures. Standardization and other appropriate QI have played a fundamental role in supporting this evolution. However, in developing countries, the situation is often very different due to factors such as:

» Food-borne diseases that are often a huge problem due to the size of the informal sector in the food industry, which is often a major component of domestic markets.

» Rudimentary hygiene controls are exacerbated by domestic food control systems that are highly fragmented with multiple food control agencies with specific areas of control. This often creates significant problems due to a lack of coordination. It also hinders their ability to perform effective market surveillance tasks (both in relation to domestic and foreign suppliers).

» Public and private institutions lack the resources (human, financial, technical) and capacity to successfully fulfil their missions.

» In many countries there is a "double track" approach where a specific agency is used to certify high value-added products for export, whilst domestically traded food and food products are subject to much less control.

To date, the development of agriculture has been achieved primarily through:

» Focusing agricultural production on a small number of key high-yield crops.

» High intensity usage of specific inputs (notably water and fertilizers, along with pesticides).

» Dependency on oil and gas, to power machinery equipment and as the basis for producing the most widely used fertilizers and pesticides.

In many cases this set of interrelated activities have also been responsible for creating environmental disruption (e.g. deforestation), soil degradation (e.g. due to the tilling and irrigation practices of intensive agriculture, especially on unsuitable land) and pollution (agricultural waste and pollution deriving from the excessive use of fertilizers and pesticides). Modern agriculture is also responsible for a significant contribution to anthropogenic greenhouse gas (GHG) emissions, as much a 25% according to the International Plant Protection Convention (IPPC) 2014, which paradoxically creates major challenges for its future.

Addressing the goals of SDG 2 requires increased investment in agriculture to enhance agricultural productive capacity in developing countries. There is also a need to correct and prevent trade restrictions and distortions in world agricultural markets. Measures must be developed, agreed and adopted to ensure the proper functioning of food commodity markets, including the limitation of extremes in food price volatility. At the same time, already depleted land and water resources are increasingly under pressure. Unsustainable agricultural practices, amongst other human activities, jeopardize biodiversity and ecosystems in general. The multiple impacts of climate change due to unabated GHG emissions also add to the pressure on the natural resource base while exacerbating inequalities between and within countries.

3. The Role and Application of QI

In all developed, and in many developing countries, there are national authorities[18] who are responsible for the legal framework applicable to food products and its associated enforcement. Such legal frameworks normally provide mandatory requirements, rules and modalities of compliance for food products, food production and distribution processes, as well as agricultural inputs directly related with human health and safety. They must therefore be observed by any supplier of food products operating in the country, including importers. These mandatory requirements and related compliance procedures address a broad variety of aspects.

For agribusinesses, mandatory requirements and related compliance procedures can include aspects such as:

» Equipment supporting agricultural activities (e.g. irrigation equipment, including pipes, valves, sprinklers, and so on, or machinery equipment such as tractors, trailers, ploughs, harrows, harvesters and so on – along with their parts).

» Seeds, plants, animals, animal feed and other key agricultural inputs such as fertilizers and pesticides.

» Guidance on agricultural practices.

For the food industry, mandatory requirements and related compliance procedures can include aspects such as:

» Health, safety and quality of food products.

» Requirements for processing, production, packaging, storage and delivery of food products.

» The definition of ingredients, information on and labelling of food products; classification of origin, and traceability along the value chain.

Although agricultural practices are usually addressed under the responsibility of agricultural ministries, specific issues, such as food safety, often fall within the mandate of other authorities. It is also important to note that these national systems are complemented by international organizations and agreements. Their objective is to promote agricultural development while managing safety, consumer protection, plant and animal health, with particular attention to issues related to cross-border activities and trade. There are three intergovernmental organizations that provide international standards and guides concerning food products and processes, plant and animal health. These organizations are the Codex Alimentarius Commission (CAC), the International Plant Protection Convention (IPPC), and the Office International des Epizooties (OIE), renamed in 2003 as the World Organisation for Animal Health. These are officially recognized as providers of international standards by the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)[19]. The SPS Agreement encourages governments to establish national SPS measures consistent with international standards, guidelines and recommendations. Although the standards these three organizations provide are voluntary, they can and are used by member states as a basis for national legislation. This practice is encouraged as the national SPS measures based on such international standards are not deemed to constitute trade barriers according to the SPS Agreement.

In order to protect Canada's reputation for quality fish and seafood and the livelihoods of those who work in the industry, there is an ongoing need to sustainably deliver accurate, reliable, and consistent test results for detecting aquatic animal diseases. The ever-increasing growth in the global trade of wild and farmed fish and seafood products also increases the risk of transferring aquatic pathogens (disease-causing agents) from one part of the world to another. The presence of these pathogens could have a devastating effect on wild fisheries and aquaculture operations through their effect on the ability of subsequently infected marine species to grow, reproduce, or survive. To further enhance the credibility of test results, Fisheries and Oceans Canada sought and have received accreditation for the in-house diagnostic laboratories of the National Aquatic Animal Health Laboratory System (NAAHLS). This provides Canada's trading partners with confidence in the diagnostic testing and has enabled the Canadian Food Inspection Agency (CFIA) to attest to the health status of Canada's fish and seafood exports, while ensuring that imports from other countries pose no risk of transferring infectious aquatic pathogens to Canada. For similar reasons, the Norwegian Directorate for Fisheries require inspection bodies evaluating floating fish farms to be accredited. They also require that the assessments of the waterways where fish farms are to be located are undertaken by accredited conformity assessment bodies.

[18] In the European Union a harmonized set of legal requirements is applied by all member states.

[19] The world Trade Organization, Available at: https://www.wto.org/english/tratop_e/sps_e/spsund_e.htm

[20] The World Health Organization is a specialized agency of the United Nations that is concerned with international public health.

The Codex Alimentarius Commission (CAC) was established by the World Health Organization (WHO)[20] and the Food and Agriculture Organization (FAO)[21] to protect consumer health and promote fair practices in food trade. The commission adopts a collection of standards, guidelines and codes of practice known as the Codex Alimentarius, or "Food Code". Codex standards are adopted by consensus and are based on the best available scientific and technical knowledge. Codex standards, guides and codes of practice include principles of food hygiene practices, guidance on composition and labelling of foods including health or nutrient information, indications of the maximum level (ML) for a contaminant that is legally permitted in a food or feed commodity and the indication of maximum residue limits (MRLs) for pesticides in specific food items, or in groups of food or feed, that are traded internationally.

The International Plant Protection Convention (IPPC) is an international plant health agreement, established by member countries of the FAO. It aims to protect cultivated and wild plants by preventing the introduction and spread of pests into endangered areas and fostering cooperation in the control of pests of plants and plant products. The IPPC develop international standards for phytosanitary measures (ISPMs) for safeguarding plant resources. These address, pest surveillance, survey and monitoring, import regulations and pest risk analysis, compliance procedures, phytosanitary inspection methodologies, pest management and export certification.

The Office International des Epizooties (OIE), World Organisation for Animal Health, is the intergovernmental organization responsible for improving animal health worldwide. The OIE develops international standards for animal health and welfare through the work of recognized scientific experts. These standards are designed to prevent and control animal diseases, ensure the sanitary safety of world trade in terrestrial and aquatic animals and animal products, and improve animal welfare.

The Global Food Safety Initiative (GFSI) is a leading global, business-led initiative addressing food safety. It is applied by major international retailers, food service chains, and manufacturers. A food safety certification programme is 'recognized' by GFSI when it meets internationally recognized food safety requirements, developed by a multi-stakeholder group, which are set out in the GFSI Benchmarking Requirements. GFSI is not a certification programme in itself, nor does it carry out any accreditation or certification activities. Certification to a GFSI recognized certification programme, such as GLOBALG.A.P., is achieved through a successful third-party audit against any of the certification programmes that have been recognized by the GFSI. The International Organization for Standardization (ISO) is also an important developer of internationally harmonized voluntary standards in this area. These include standards for agricultural equipment, the determination of properties or the concentration of food commodities and the limits of chemical and natural substances in food. In addition, the ISO 22000 series provides a broadly applicable platform for supporting food safety management.

The QI institutions and services they provide already have a fundamental and demonstrable role in the support of trade in food and agricultural products. They now need to appropriately evolve to facilitate the development of sustainable agriculture. There are many areas where QI services can be extremely important. These include:

» Standards, chemical metrology, test and inspection procedures and certification processes addressing methods and technologies for sustainable agriculture such as soil management[22], irrigation and water management, and integrated pest management.

» Multi-stakeholder voluntary sustainability standards (VSS), chemical metrology, test and inspection procedures, certification processes and related procedures covering specific agricultural and food sectors and their value chains. Many of these programmes are already broadly recognized by international retailers, business partners and consumers, and provide a significant incentive to producers, particularly SMEs, in terms of market access.

» Evolving and emerging technologies, with related guidelines, conformity assessment and other tools to support land use and monitoring. These will be particularly important in relation to policy frameworks that aim to promote and reward sustainable agriculture.[23]

In response to a major scandal in the local food sector in 2012, the Dutch Minister of Health, Welfare and Sport and the Dutch Minister for Agriculture established a Food Confidence Task Force in March 2013 together with the meat, dairy and animal feed sectors. Its objective was to determine and implement measures to restore consumer confidence in domestic food products. A substantial element in regaining consumer confidence was to reinforce food safety and integrity in both the public and private sector. The important role of private quality schemes was also recognized. In cooperation with the Netherlands Food and Consumer Product Safety Authority (NVWA), the task force has defined a set of criteria for private sector quality schemes to address food safety and specifically food integrity. Quality schemes that have subsequently proven to comply with these criteria can be found at: www.ketenborging.nl. Businesses can now check this information to determine if current or potential partners are certified by a quality scheme that meets the required criteria. This recognition also assists NVWA in adapting or even reducing its supervision requirements for those organizations certified under these recognized schemes.

[21] The Food and Agriculture Organization of the United Nations is a specialized agency of the United Nations that leads international efforts to defeat hunger.

[22] FAO, Voluntary Guidelines for Sustainable Soil Management, 2017.

[23] The European Environmental Bureau (EEB), Position Paper on the Future of CAP, 2017.

4. The Way Forward

Agriculture is an essential sector for developing countries and economies in transition. It provides food, employment and other basic resources. In many cases it also acts as an important source of foreign currency through exports. The future of agriculture also presents daunting and diversified challenges. For countries with high population density and limited agricultural land, a key objective is to achieve high crop productivity and resource use efficiency, to ensure food security coupled with environmental sustainability. For the least developed countries, the overarching goal is to eradicate hunger and to secure adequate nutrition to all people, especially children. For a significant number of developing countries, further challenges concern the need to improve control systems to ensure the adequate health and safety of food products.

Addressing these challenges requires substantial and coordinated efforts at international and national levels from both public and private sectors. Issues that need to be addressed include:

» The improvement of health and increased safety of food products will require the appropriate and targeted development and strengthening of national and regional quality infrastructures.

» Active and insightful participation in related international activities coupled with synergistic collaborations at the regional level.

» Activities and programmes focused on the informal sector including the dissemination of information, capacity building and supportive and affordable QI services, as well as creating synergies with the formal sector.

UNIDO technical assistance is promoting a national culture for quality, and improving the compliance capacity of SMEs in the coffee and cocoa sector with international standards and technical regulations. Collaboration with the National Quality Institute (INACAL) and the Technological Institute of Peru (ITP) aim to strengthen relevant innovation and technology centres (CITE) to provide demand-driven quality services to the producers and exporters of coffee and cocoa in their production zone. Proper post-harvest processes and technologies have continuously been identified as a major bottleneck that affects the quality of the coffee and cocoa value chains. The project has identified the need to develop best practices and the normative framework for both coffee and cocoa.

See: https://www.unido.org/news/unido-and-swiss-confederation-work-together-quality-and-compliance-peru

5.2 Good Health and Well-Being

SDG 3 - Ensure healthy lives and promote well-being for all at all ages.

SDG 3 calls for action on a long list of health issues - from reproductive, maternal and child health to communicable, non-communicable and environmental diseases. It promotes access for all to safe, effective, quality and affordable medicines and vaccines and calls for more research and development, increased health financing, and strengthened capacity of all countries in health risk reduction and management.[24]

Population growth, longer life expectancy, increasing international travel and trade, as well as innovations in modern medicine are placing an ever-growing demand on health care systems. Government authorities mandated to protect the health and safety of citizens need access to appropriate QI capability and capacity. They also need to work together with others to fulfil their assigned regulatory and international responsibilities. Policies, guidelines, and regulations that cover health and safety-related 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. The appropriate use of metrology, standards, accreditation and competent CA bodies to underpin health and safety-related requirements and regulations is therefore critical.

1. Health and Economic Growth

Health contributes to and also benefits from many other SDGs in major ways. A healthy workforce is more productive and healthy children learn better. Health care influences life expectancy. Unsafe drinking-water or sanitation, pollution, and poor housing all impact negatively on health and are other areas where the SDGs call for focused attention. The structure and organization of health care vary widely across countries. Local social and cultural norms and economic conditions strongly influence the way in which health care is supplied. Improving human health and providing access to affordable, high quality health care is a key concern especially for developing countries where substantial proportions of the population are poor and have only limited or no access at all to basic health care services.

SDG 3 also calls on governments to also take decisive preventive action for the protection of populations. The list of measures extends to road accidents and pollution, which fall outside the mandates of health authorities. According to the World Disasters Report, 70% of road fatalities occur in developing

[24] See UN Sustainable Development Knowledge Platform portal, Available at: https://sustainabledevelopment.un.org/sdg3

countries and the cost of traffic accidents in these countries is roughly the level of all international aid.[25] Another study forecasts that as the number of cars is rising, particularly in developing countries, by 2020 road fatalities will be the third highest cause of global death and disability, just behind clinical depression and heart disease.[26] Health authorities must raise societies´ awareness of the risks for life and health posed by behaviours, practices and changing conditions of people's living environment and engage with agencies in charge of road safety and other stakeholders to develop preventive measures.

2. Challenges and the Achievement of Transformational Needs through the SDGs

Health outcomes depend on services which hospitals, providers of primary care and medical labs offer. Because the quality and safety of patients are inextricably linked, strategies to strengthen national health systems are suboptimal and may even fail unless standards for acceptable performance of health services offered throughout the health care system are set and enforced. Many countries operate health services under tight budgets and procure needed equipment, including refurbished equipment and donations, paying attention to costs but not necessarily to quality requirements. Weak controls and sanctions encourage rather than deter opportunistic behaviour. Commercial suppliers can market inferior faulty products or engage in other illegal practices that put lives at risk. There is a vast body of reference material, including the WHO Medical Device Regulations Guide (2003), that countries can use to set up appropriate national regulatory systems and improve on them. One of the priorities identified is establishing vendor and product registrations.

The quality of service in a hospital, primary care facility or medical laboratory can deteriorate for a variety of reasons, including financing problems, poor patient record keeping and difficulties with attracting new or keeping existing qualified staff. A study (2012) looking at patient records in 26 hospitals in eight countries in the Middle East and Africa found that more than one death per day in every hospital was due to preventable accidents and poor treatment linked to poor management rather than a lack of resources. On average 8.2% of the patients whose hospital records were examined suffered unintended injuries that resulted in permanent disability or death that came about as a result of health care management, and in some hospitals the average rose to almost 20%.[27]

Consideration should be given to ways of encouraging the supply of simpler medical apparatus. What is needed in developing countries is basic, low-maintenance equipment, much of the donated equipment is often not used because hospitals do not have the trained personnel to use it or do needed repairs. By one account, only 10-30% of donated equipment is actually used, the reasons being mismanagement in the acquisition process, lack of user training and lack of effective technical support.[28]

A growing segment of the pharmaceuticals industry is producing and selling generic medicines on the global market, that are cheaper than the brand-name patented equivalents. The margins of these companies are lower, and they are keen to extend low price access for patients. To the extent that global generics players take market shares from patented brands, this offers further scope for buying medicines at lower prices. Today, Brazil, China and India have built local industries producing generics for the global market and are often cited as examples that other developing countries could follow, it should however be noted that the chemical and biological stages involved in manufacturing medicines require skilled scientists and engineers, laboratory facilities and instruments which are scarce in many countries and practically non-existent in the least developed countries.

3. The Role and Application of QI

While there is thus no universal model of delivering services, the societal value of any health care system depends on its capacity to generate benefits to health. Interventions and preventive actions must be safe and effective in saving and protecting lives and delivering other desired health outcomes, and they must be accepted and used by people in need. Given that safety and quality and related control functions are so critical to the protection of life and the health of people, QI institutions and services play a pivotal role throughout the health sector and are among the core capabilities enabling national and internationally coordinated actions that improve the performance of this sector.

Consistent high performance to acceptable standards is the cornerstone of quality assurance in health care. Standards of care can be developed by different stakeholders, including hospitals themselves or ministries of health. Professional organizations, the WHO and accrediting organizations are developing and updating consensus standards and guidelines for health care professions and hospitals and other organizations. These documents and their translation into operational criteria against which performance is evaluated are the work of health care experts, they therefore reflect state-of-the-art thinking about health care quality, advances in technology and treatments, and changes in health policy.

[25] International Federation of Red Cross and Red Crescent Societies, International Disasters Report, 2016. Available at: http://www.ifrc.org/Global/Documents/Secretariat/201610/WDR%202016-FINAL_web.pdf

[26] World Report on Road Traffic Injury Prevention, Available at: https://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/

[27] Study authored by Ross Wilson et al (2012), and findings cited in: https://www.bbc.com/news/health-17359796.

[28] WHO, Barriers to innovation in the field of medical devices, Background paper 6, Geneva, 2010, and WHO Medical device donations: considerations for solicitation and provision, Geneva, 2011.

Medical measurements are an everyday part of health care 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 health care 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.

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.

Critical inputs for interventions and other services by hospitals, health centers and other health service providers include medical apparatus and other medical devices. From manufacturing standards and quality assurance systems at production sites to control systems which government can operate at the border and in the domestic market, a QI provides the necessary tools for rendering medical devices safe and fit for their purpose and keeping inferior products from entering the market. The sharing of practices and international standardization work has made it possible that information about effective and internationally recognized production management systems and regulatory policies is universally available.

With UNIDO support, a West African Accreditation System (SOAC), covering 8 ECOWAS member states was established. SOAC issued an accreditation certificate to the National Public Health Laboratory (LNSP), a public laboratory which offers testing services for iodine levels in food salt. In 2014, 130 countries (roughly 38%) of the world's population, representing more than 2 billion people, were affected by iodine deficiency. The consequences of this deficiency were goiters, cretinism, low birth weight, endemic mental deficiency, and high perinatal mortality rates. The most affected were pregnant women and young children. West Africa has made progress in treating this disease. However, one of the systemic weaknesses in dealing with the disease has been the lack of competent laboratories to assess and test the right iodine content in salt that is sold in the markets. With its SOAC accreditation, the LNSP is able to provide this service.

Production management systems and regulatory policies are routine in the developed world, where the production of much of the medical equipment and sales markets is concentrated. They also need to be promoted in developing countries, where regulatory controls are not always strong. Similar controls must also ensure that another major input into health care, medicines, meet safety and quality requirements. Guidelines on good manufacturing practice (GMP) for pharmaceuticals, covering risk assessment, labelling and other aspects of their production have been issued and are regularly updated by the World Health Organization (WHO), mandated to elaborate global standards and guidelines for the quality, safety and efficacy of medicines.[29]

Affordability of medicines is another important issue, which must be addressed as part of national and international efforts to improve access to medicines for poor people. The potential contribution of a QI to lower prices comes primarily through efforts to remove unnecessary transaction costs created by the regulatory requirements of selling pharmaceuticals in different markets. Entry into each market usually requires separate regulatory approval and for new medicines it is particularly complex and long. Differences in national procedures can act as bottlenecks for medicines becoming available for people and potentially saving millions of lives. It is thus important to identify and reduce unnecessary duplication, which will speed up approvals and may reduce costs and prices.

4. The Way Forward

Quality of care assurance and improvement are essential components of health system strengthening. One objective of quality assurance is to maximize the effectiveness and efficiency of the existing system and its organizations. This gives governments, public or private health care providers and communities the possibility to realize even more benefits from their existing investments in health care.

Rapid access to laboratory facilities are an essential prerequisite for the capacity of a country facing medical emergencies, e.g. a yellow fever outbreak. This is required to apply the WHO guidelines on yellow fever laboratory diagnostic testing algorithms and give timely laboratory confirmation of suspected yellow fever cases. Political commitment to the local training of researchers and equipping them with the laboratories, offices and equipment needed, can also be a way to stop 'brain drain' and give incentive for researchers getting training abroad to return home or to stay in their home country to work. For research infrastructures to be sustainable over time, the research must be valuable to local user communities, i.e., there must be economic social and political support for the research.

[29] See WHO site, Available at: http://www.who.int/medicines/areas/quality_safety/quality_assurance/norms_standards/en/

5.3 Affordable and Clean Energy

SDG 7 - Ensure access to affordable, reliable, sustainable and modern energy for all.

SDG 7 promotes energy efficiency policies, technologies and practices, as well as access to affordable renewable sources of energy for the facilitation of productive activities, providing countries with an opportunity to follow a low-carbon and low-emissions growth path.

Affordable and clean energy, especially electricity, impacts on many other SDGs and indeed the development of every nation and economy. There are International Electrotechnical Commission (IEC) standards that enable all forms of power generation, including on-grid and off-grid use of good quality renewable solar, wind, marine and hydro energy generation. Such standards also provide the basis for rural electrification, microgrids, low voltage direct current (LVDC) applications and safer, more reliable and efficient devices. The International Telecommunications Union (ITU) have developed several standards for monitoring and assessing energy efficiency for telecommunication networks, equipment and related infrastructure. The International Organization for Standardization (ISO) have also published many energy-related standards, including energy performance indicators, energy efficiency assessment, and energy data management for buildings. There are also standards that address emerging technologies such as solar power and biofuels. The provision of energy involves complex supply chains and processes, often involving cross-border trade and the transportation of volatile substances. Increased use of sources of renewable energy also creates challenges for distribution grids, both in terms of grid stability, but also due to the requirements of commerce for an electricity supply that is free from momentary voltage interruptions or interference sources. Measurements play an increasingly critical role at every stage of the energy challenge. Accreditation of those performing such measurements and other related CA activities provides valuable support for governments and organizations as they seek to enhance energy efficiency, and economic performance, whilst preventing unsafe, unhealthy or environmentally harmful products from entering the marketplace. All of this promotes the need for a fit-for-purpose and strategically focused QI infrastructure.

1. Energy and Economic Growth

Energy is indispensable for human activity. Industry, modern cities and transportation could not exist without an abundant energy supply. Modern life and the things now taken for granted such as in-house fresh water and sanitation, heating, cooling, cooking, lighting, use of electrical appliances, electronic equipment could also not be sustained without it. A significant amount of energy is also required for modern agriculture. The agricultural output needed to feed the world population substantially depends on hydrocarbons. These provide the fuel for tractors and all other machines used in agriculture and are also utilized in the production of fertilizers and pesticides.

Global primary energy consumption has increased 25 times between 1800 and 2015, from less than 6.000 TWh per year to over 146.000 TWh per year. Energy consumption has grown at a rate close to 2% per year since the year 2000. The energy sector is also responsible for a substantial share of the greenhouse gas emissions, which together with other forms of pollution is one of the most serious threats for humanity. Despite the enormous increase of the global energy supply and consumption that has occurred over the past decades, many people continue to lack access to electricity and to clean energy, even for primary needs such as cooking.

2. Challenges and the Achievement of Transformational Needs through the SDGs

The ability to secure a reliable and stable energy supply is essential to achieve many of the SDGs. At the same time, there are some formidable challenges to our economies and societies that need to also be addressed. There are four major challenges, namely energy demand, CO2 emissions from energy-related activities, access to clean cooking fuels and technologies and access to electricity by all people, that are now described in more detail noting that they need to be addressed in an integrated way.

2.1 Energy Demand

According to the IEA[30], the global energy demand is expected to grow steadily in the coming years, with a projected increase of more than 25% by 2040 as compared to 2017, the baseline scenario. This demand is almost entirely driven by emerging economies and developing countries, who are expected to increase their combined energy demand by 45% and increase their share of global energy demand to 70%. This scenario will require substantial, continued investment. Complex decisions, aiming to support the development path of these countries also need to be made to address the environmental and social challenges related to such increases in energy supply and use.

2.2 CO2 Emissions from Energy-related Activities

The IEA[31] states that the global energy-related CO_2 emissions rose by 1.7% to 33 gigatons (Gt) in 2018. Without substantial changes in policies and actions, they are expected to grow to 36 Gt in 2040. Given the current reliance on fossil fuels, the energy sector is responsible for about 75% of total CO_2 emissions. The trends outlined above are clearly incompatible with the 2 degrees Celsius target of the Paris Agreement as mentioned under SDG 13. Addressing this challenge will require bold and expeditious action. Decisions made today about new plants and facilities are critical,

[30] IEA, World Energy Outlook 2018.
[31] Ibid.

especially when it is noted that existing or planned infrastructures, e.g. those for power generation, buildings, factories, already account for over 20 Gt of CO_2 annual emissions up to 2040. The IEA notes that the rising role of electricity as a preferred form of energy supply, together with cheaper renewable energy technologies and the increasing availability of digital applications for managing energy efficiency, provide a crucial and timely vector for change.

2.3 Access to Clean Cooking Fuels and Technologies

According to the World Health Organization[32], around 3 billion people still cook using polluting open fires or simple stoves fueled by kerosene, biomass and coal. Each year, close to 4 million people, mostly young children and women, die prematurely from illness attributable to household air pollution from inefficient cooking practices and stoves using solid fuels and kerosene. According to the High-level Political Forum on Sustainable Development 2018[33], over the period 2000-2016 about 1.4 billion people gained access to clean cooking fuels and technologies. The rest still represent a staggering 41% of the world population and "if current trends continue, 2.3 billion people will continue to use traditional cooking methods in 2030.[34]"

2.4 Access to Electricity by all People

According to the HLPF on Sustainable Development 2018[35], "from 2000 to 2016 the proportion of the global population with access to electricity increased by almost ten percentage points, reaching 87 %. This was the first time since 1990 that the absolute number of people living without electricity dipped below the symbolic threshold of one billion." Substantial disparities still exist between urban and rural populations and among different regions of the world, with the largest deficits in Southern Asia and sub-Saharan Africa.

There are two main strategic directions related to the global 'energy transition' that is now required. These are a move to renewables and increased energy efficiency. It is imperative that countries begin to change their energy generation capability from coal and other fossil fuels towards renewable sources including solar, wind, geothermal and the sustainable[36] use of hydropower and biomass. A transition to cleaner energy forms will also alleviate local air and water pollution and contingent harmful environmental and health impacts. It is also important to consider that fossil fuel reserves are unevenly distributed geographically. By contrast, renewable sources of energy such as solar and wind exist over wide geographical areas. All countries can exploit some of them locally, and the cost of renewable "fuels" are rapidly decreasing. According to the International Renewable Energy Agency (IRENA)[37], "between early 2017 and early 2018, global weighted average costs for onshore wind and solar PV stood at US$ 6 cents and US$ 10 cents per kWh, respectively. [...] Continued technical innovations suggest that costs will fall further in the future: e.g. solar PV costs are expected to halve again by 2020 (relative to 2015-2016)". As a result, technologies for renewable electricity and heat are available, increasingly affordable, rapidly improving, and offer immense flexibility for solutions to be scaled to specific user needs.

Energy efficiency is the other primary driver to support the required energy transition. Improvements in energy efficiency are already an important factor affecting global energy demand. The IEA is urging governments and the private sector to implement policies and scale-up investment supporting the adoption of energy efficiency across all sectors, i.e. power generation, buildings and households, industry and transport, and highlighting that energy efficiency alone can already deliver substantial economic, environmental and social benefits. Investments in energy efficiency are particularly attractive because, as noted by the IEA, they pay back on average by a factor of three (based on energy savings alone).

3. The Role and Application of QI

3.1 Renewable Energy

The two leading technologies for renewable power generation currently are wind turbines and solar photovoltaic (solar PV). In both cases, standards and QI services continue to play a fundamental role in the development of these technologies. According to the IRENA[38] "Quality assurance (QA) has proven to be indispensable for establishing an enabling environment for a rapid uptake of renewable energy technologies. Quality assurance consists of standards which are intended to ensure that products and services perform as expected, as well as the mechanisms to verify that such requirements are fulfilled, e.g. testing and certification. QA builds the credibility necessary for the creation of healthy, efficient and rapidly growing technology markets and ensures that expectations from investors and end-users for technology performance, durability and safety are met."

3.2 Wind Energy

Global wind-power capacity has grown from 24 GW in 2001 to 540 gigawatts (GW) at the end of 2017, an average increase of 20 % a year during the past decade. The cost of generating wind energy is intrinsically linked to the reliable functioning of the turbine. Operational and

[32] WHO, Fact sheet: Household air pollution and health, 2018.
[33] Sustainable Development Goal indicators website, Available at: https://unstats.un.org/sdgs/report/2018/goal-07/
[34] Ibid.
[35] Ibid.
[36] Hydropower and biomass (including crops, agricultural and organic urban waste) are renewable energy sources if properly implemented. If not, they may be counterproductive – e.g. they may increase emissions due to bad land use (e.g. deforestation, destruction of peat land) or construction activities, or generate adverse social effects (e.g. competition between food and biofuels).
[37] IRENA, Global Energy Transformation: A Roadmap to 2050, 2018.
[38] IRENA, Quality Infrastructure for Renewable Energy Technologies – Guidelines for Policy Makers, 2015.

maintenance costs represent an important component of the total lifetime cost of wind turbines. Appropriate standards concerning the design, construction / installation and operation of wind turbines, and wind farms, are extremely important. As are the related conformity assessment activities, particularly inspection and certification, needed to assess the initial and ongoing compliance of these products and projects. The IEC 61400 series of standards provide internationally accepted requirements that address design, implementation criteria to ensure engineering integrity and an appropriate level of protection against damage from all hazards during the planned lifetime. These standards are complemented by other appropriate IEC and ISO standards, along with a variety of national standards and regulations, and certifications schemas aiming to ensure safety, reliability and quality of installations. Almost all large-scale wind turbine installations are certified according to certification schemes such as IEC 61400-22 or schemes provided by certification bodies or other authorities.

3.3 Solar photovoltaic (PV) Energy

Global solar photovoltaic (PV) capacity has grown from less than 5 gigawatts (GW) in 2006 to 404 GW at the end of 2017, an average increase of about 50 % a year. An IRENA[39] report published in 2017 notes that solar PV systems are now a very competitive power supply option and, with trillions of U.S. dollars at stake, "more efforts should be made to ensure that these systems deliver as expected throughout their lifetime"[40]. In this respect, the same report states that "Quality assurance (QA) is crucial in order to reduce electricity costs, since it contributes to ensuring stability for the investors and other stakeholders and it is an essential instrument to protect and accelerate future investments in PV deployment." The role of a QI is fundamental for the holistic approach to quality required to support the consolidation of the solar PV market and, more importantly, its rapid expansion. QI institutions and services are required that cover the various components of equipment, as well as installation, operation, maintenance and end of life management of these systems.

In Japan, the government relies on accredited testing and certification of renewable energy products to provide confidence in the market. Products such as wind turbines or PV solar panels are tested by an accredited laboratory to measure performance, durability, safety and environmentally friendly considerations. Installation companies are required to obtain accredited certification to demonstrate compliance. Accreditation is specified as appropriate in state tender requirements to benefit from reduced pollution, energy costs, increased competition, and informed supplier selection

[39] IRENA, Boosting Solar PV Markets: The Role of Quality Infrastructure, 2017.

[40] Ibid.

3.4 Energy Efficiency

Energy efficiency is the other fundamental pillar of energy transition which can, potentially, deliver the largest contribution to GHG emission reductions. Apart from the increased efficiency of energy utilities, the largest potential energy efficiency gains concern the main energy use sectors: transport; building and appliances, and industry. Energy efficiency can be driven / promoted by policies and regulations such as:

- mandatory minimum energy performance standards (MEPS) for appliances and equipment, mandatory building codes, fuel economy standards and targets for industry.
- Incentives to encourage the adoption of energy-efficient technologies and practices, including grants and subsidies, tax relief, equity finance, loans and debt finance.

The actual energy consumed is impacted by technologies, usage patterns and other conditions. Such complexity presents a challenge for organizations seeking to understand and manage energy consumption efficiently. They often do not have the expertise in the management and control of energy and materials. This is a barrier to making business models more sustainable which a QI has been instrumental addressing. Energy management systems (EnMS) have now emerged as a best-practice approach for businesses to achieve energy efficiency gains. This has given rise to an international standard, ISO 50001, which organizations in all sectors and of any size can use to methodically and continuously track and analyze energy use, and act on findings to improve energy efficiency, or make use of renewables. The standard is based on the same management system model of continual improvement used for ISO 9001 and 14001, which makes it possible for organizations to integrate energy management into their quality and environmental management systems. Industry-tailored guidance has been found to greatly facilitate adoption of an EnMS. There is evidence that industrial enterprises that have implemented an EnMS are achieving much higher annual energy savings compared to enterprises without an EnMS. [41]

In the United Arab Emirates (UAE), the Sharjah Electricity and Water Authority (SEWA) is one of three government utilities that have now implemented ISO 50001 (energy management systems). Within one year of implementing this standard they achieved an energy saving of just over 7% equating to an energy cost saving of US$ 26,000. Implementing ISO 50001 was one of SEWA's strategic initiatives for the fulfilment of its vision towards achieving environment and energy conservation, maintaining load growth, and meeting sustainability and climate change objectives.

[41] From UNIDO Bridge Training document, p. 3.

4. The Way Forward

Economic development and prosperity are strictly dependent on the availability of abundant and affordable energy. A large part of the world population continues to lack access to electricity and to clean energy for primary needs such as cooking. The transformation needed to successfully achieve SDG 7 will require concerted and sustained efforts by all of the actors involved namely, governments, financial institutions, the private sector, civil society organizations, and concerned citizens. The challenges ahead are even greater for developing countries. They need to continue to build or expand infrastructure to provide universal energy access and also address specific challenges including safe and affordable cooking devices. A QI proves indispensable to support in the implementation of effective and efficient regulatory frameworks and market processes regarding the energy transition.

Mexico has implemented a policy, supported by EE standards, to establish a fund to facilitate the reduction of emissions in energy consumption by replacing incandescent light bulbs with compact fluorescent light bulbs, together with a project for energy-efficient refrigeration to reduce energy consumption. The National Commission for Energy Efficiency (CONUEE), a decentralized, administrative agency of the Secretary of Energy, with technical and operative autonomy to promote energy efficiency, is responsible for developing EE standards. All products, processes, methods, facilities, services or activities must comply with these EE standards that are published in the Official Gazette (DOF). To demonstrate compliance with these mandatory standards, products such as refrigerators, air conditioners, laundry machines and water heaters must be certified. The certification and related testing must be performed by accredited third-party conformity assessment bodies. There are also other schemes in the Mexican market, such as the Electric Power Saving Trust Fund (FIDE), a voluntary label that identifies energy-efficient products and certifies that products meet specified standards and identifies them as FIDE certified energy-efficient products. FIDE also requires conformity assessment bodies to be accredited to issue its certificates.

Efforts to establish or strengthen national QI should continue to be part of national and regional development priorities, especially considering these activities can unlock significant downstream investment. Solutions based on renewable energy should be prioritized and systematically adopted for new power generation plants. In this respect, important enablers for acquiring knowledge and ability of deployment are active involvement in the development of standards for solar PV and wind turbine solutions, smart grids and energy storage technologies. There is also the need for understanding and utilizing the other QI components in supporting the design, installation and operation of the diverse variety of plants and installations based on such technologies.

Greater adoption of energy efficiency measures should be followed for the:

- Design of new structures (e.g. buildings, industrial plants and various components of the transport system).
- Operation of existing structures.
- Production and expanded use of energy efficient devices (e.g. lighting, heating and cooling, cooking, etc.).

The adoption and implementation of standards, accreditation and conformity assessment schemes for buildings and industrial applications (e.g. electrical motors), of energy labelling of electrical appliances and other devices should also be actively pursued as either voluntary or mandatory measures, depending on the context and local priorities. In this context, the use of solar PV, off-grid (or micro-grid) solutions, combined with the use of affordable and efficient appliances and lighting devices, are an increasingly important option. The use of a QI in the support of the manufacturing and maintenance of off-grid solar PV equipment, along with guidance for installers and local communities, are important tools to support the dissemination of such solutions. The use of a recognized QI also helps build the trust and confidence required for attracting financing and support from international financial and other donor organizations.

While small hydropower (SHP) is increasingly recognized as an important renewable energy solution to the challenge of electrifying remote rural areas, the potential of SHP in many developing countries remains untapped. To foster this uptake, UNIDO supported the development of technical guidelines to serve as a basis for international standards for SHP development. The guidelines address the current limitations of the regulations applied to the planning, design, installation, commissioning, operation and management of small-scale hydroelectric generating plants. In addition, they will be used to train manufacturers, engineers and decision-makers, particularly in developing countries. According to UNIDO Director General Ll Yong, “the project will help the development of efficient and sustainable SHP which will, in turn, provide the power for productive activities and create employment opportunities. The technical guidelines will make it possible to develop small hydropower, and with training technology transfer will become a reality.”

See: https://www.unido.org/news/government-china-and-unido-partner-develop-technical-guidelines-standards-small-hydropower-development

5.4 Clean Water and Sanitation

SDG 6 - Ensure availability and sustainable management of water and sanitation for all.

SDG 6 assists countries with the transfer of best available technologies and environmental practices to improve industrial and municipal water management and productivity and helps prevent the discharge of industrial effluents into international waters (rivers, lakes, wetlands, and coastal areas).

Few challenges are more global than water. Rivers and lakes cross national boundaries while oceans are shared resources. Droughts, floods, and climate change cut across continents. The need for improved management of water demand and supply, including universal and equitable access to safe drinking water, can only but increase. This implies the increased promotion and implementation of water efficient production methods and clean technologies, nationally, regionally, and globally. National and international strategies in this area need to ensure that all associated QI-related needs are appropriately coordinated and mutually supportive. Internationally harmonized standards for water also assist in providing global tools to help manage these shared water resources, increase the efficiency of water distribution services, and reduce leakages, preventing unnecessary water losses. Water quality standards for the safe and efficient use of wastewater for irrigation can also ease the strain on water resources, particularly important when agriculture accounts for about 70% of the world's freshwater consumption. The appropriate use of a QI system provides an important enabling and quality assured way of addressing these challenges.

1. Clean Water, Sanitation and Economic Growth

Availability of water in large quantities and proximity to water ecosystems have been essential for the development of human civilizations. At the opposite, severe water shortages, determined by prolonged draughts or by mismanagement of water resources, have been among the primary causes of the collapse of civilizations.[42] The organization of water supply and sanitation throughout history has not been a linear process of improvement, along with the relationships, regarding wastewater management, between cities and their agricultural surroundings. It should not be forgotten that the importance of proper sanitation was not scientifically understood until the late 19th century.

At a global level, fresh water is primarily used in agriculture (almost 70% of the total, including irrigation, livestock farming and aquaculture), followed by industry and power generation (almost 20%) and by domestic use (over 10%). Water demand is increasing for all types of use: agriculture needs to feed a growing population and support evolving diets (more water intensive), many industries, notably extractive and heavy processing industries, require increasing quantities of water, and rapid urbanization patterns put additional pressure on water resources. Moreover, all these water uses, if not managed properly, pollute freshwater resources with substantial negative impacts. Considering that 1.4 billion people's jobs (in food and beverage, extractive and water treatment industries) depend directly on water, and that the livelihood of hundreds of millions of small holder farmers is based on water, it is evident that preserving and carefully managing water resources is imperative for economic development. UN Water notes that "Economic growth is still a priority for most countries. SDGs cannot be met without growth, which tends to overshadow other issues." But it warns that "unsustainable borrowing from water and land resources will not help to meet these targets."

2. Challenges and the Achievement of Transformational Needs through the SDGs

Major trends already outlined in the previous section e.g. population growth, urbanization, agricultural intensification, land use change, industrial development, transport and trade contribute to the depletion of water resources and to the pollution of water ecosystems. Climate change is expected to make things worse, especially in relation to modified rainfall patterns, more frequent and severe draughts and acceleration of desertification. This gives an idea of the global challenges that must be addressed in relation to water. In their report "Making Every Drop Count: An Agenda for Water Action" The High-Level Panel on Water (HLPW) note that "More than two billion people are compelled to drink contaminated water, resulting in a child dying every minute of every hour of every day. 4.5 billion people lack safely managed sanitation services. [...] About 2.5 billion people (36% of the world's population) live in water-scarce regions where more than 20% of global GDP is produced. By 2050, more than half of the world's population, and about half of global grain production, will be at risk due to water stress. Intense water scarcity may displace as many as 700 million people by 2030." [44]

Access to safe and affordable water and to adequate and equitable sanitation and hygiene are major challenges. The lack of safe water, sanitation and hygiene (WASH) services is a major risk factor for infectious diseases and mortality, which disproportionately affects regions such as sub-Saharan Africa and Central/Southern Asia. A related challenge concerns water contamination/pollution. Freshwater can be polluted by pathogens (typically from human and animal waste), organic matter (primarily agricultural run-offs of agricultural inputs such as nitrogen and phosphorus), chemicals from industrial activities (including heavy metals and

[42] Drought experts Justin Sheffield and Eric Wood, in their 2011 book, Drought – past problems, future scenarios, describe the collapse of 10 major civilizations for which the impact of prolonged draughts has been a primary factor.

[43] UN-Water, Synthesis Report 2018 on Water and Sanitation.

[44] High Level Panel on Water (HLPW), Making Every Drop Count: An Agenda for Water Action, 2018.

other toxic substances), oil spills, persisting organic pollutants (POPs), primarily including pesticides. Emerging types of water contaminants also include plastics and pharmaceuticals. Once contaminated, water may no longer be used for specific activities (e.g. drinking, irrigation) and may cause serious damage to ecosystems. Particularly worrying is the deterioration of groundwater quality caused by the leaching of agricultural run-offs, seepage of urban and industrial effluents, and irresponsible disposal of hazardous waste.

The HLPW has estimated the economic loss from reduced environmental services due to water contamination to be over US$ 4 trillion between 2007 and 2011. An additional major challenge concerns the increase of contamination from industrial wastewater deriving from the shift of production from industrialized countries to emerging economies and developing countries, that in many cases are not really prepared for the challenge; this is particularly important in the case of heavy-processing and high environmental-impact industries.

Another challenge concerns water conservation. This applies to surface water (rivers and basins) and most importantly to groundwater, the freshwater that is increasingly used also as a consequence of surface water lost from drought-depleted lakes, rivers, and reservoirs. Groundwater represents nearly 98% of accessible freshwater resources and has always been a source of good quality water for human needs. However, in modern times, thanks to scientific and technological progress (e.g. geological knowledge, drilling, pumping, availability of energy) and surging demand, the use of groundwater has dramatically increased.

There is a growing consensus that such water-related challenges can be met only by adopting a more integrated approach to managing and allocating water resources. the concept of integrated water resources management (IWRM)[45] is embedded in the 2030 Agenda. It requires governments to consider how water resources link different parts of society and how decisions in one sector may affect water users in other sectors. It is an approach that must involve all actors and stakeholders, from all levels, who use and potentially pollute water so that it is managed equitably and sustainably. Addressing these and the other challenges already identified will require substantial, coordinated and focused international efforts that include the need to identify, develop and strengthen appropriate regional and national QI capabilities and capacities.

3. The Role and Application of QI

The protection of the water resource against pollution and catering to people´s needs for safe drinking water hinges on national, legal and regulatory frameworks setting forth and enforcing standards for the quality of the water resource and the different end point uses of water. Access to an appropriate QI gives national and local regulatory authorities, public or private operators of water and wastewater services, industries, households and other stakeholders the technical capacity for taking action. A QI can be used to ensure that water reticulation delivers water that is fit for drinking, that pollution is being controlled and assist in promoting water efficiency and conservation. Many countries, and especially developing countries, need to improve on existing or build new physical infrastructure for water reticulation. This includes extensions to existing large centralized systems but also decentralized mechanisms for supplying water to distant or small communities. Developing countries must also invest in expanding wastewater networks and building and maintaining the infrastructure to collect and treat sewage and wastewater.

3.1 QI and Access to Safe Water

The WHO Guidelines for Drinking Water Quality (GDWQ)[46] provide a framework for operating safe drinking water systems, which include health-based targets (to be set by national authorities), water safety plans (WSP), to be developed and managed by water suppliers, and independent surveillance, to be undertaken by an independent body (often under the responsibility of the Ministry of Health). Subsequent national regulations normally identify a list of organic and inorganic substances for which mandatory limits should be met, along with monitoring requirements and criteria and practices for quality surveillance. All of these aspects normally use the WHO Guidelines as the scientific reference, however organizations have issued complementing normative documents.

> ISO has developed some 300 standards for water quality, including drinking water, focused primarily on characterization of water properties, of contaminants in water and related test methods. National or sectoral standards are also used, often to technically complement national regulations.

Public and private investors can draw on a QI for information about technology options. When choosing pipes, treatment equipment and other hardware that would be fit for local circumstances, they can refer to quality and other criteria available in international, regional or national standards, which define how pipes, fittings and valves suitable for the reticulation of water should perform and interconnect. Countries can also experiment with local innovations e.g. to cost-effectively and quickly install small-scale water delivery systems and then use the process of standardization to share proven novel applications with potential users worldwide.

[45] IWRM is defined by the Global Water Partnership (GWP) as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

[46] WHO Guidelines for Drinking-Water Quality, 4th edition, 2017.

Water and food safety are essential parts of everyday life. Accreditation provides independent assurance so consumers, suppliers, purchasers and specifiers can have confidence in the quality and safety of goods and the provision of services throughout the supply chain. Samples, products, services, management systems or personnel can be evaluated against specified requirements by accredited laboratories, inspection and certification bodies and as part of checking that water is safe for consumption.

3.2 QI and Water Contamination

Addressing water pollution at its various sources is a critical aspect of sustainable water safety management. Public authorities must address the lack of sanitary facilities for households, the uncontrolled disposal of sewage and industrial waste into the environment and set discharge or effluent guidelines for chemical and other water pollutants for specific industries.

A UK Code of Practice defines an assessment method which allows the manufacturers of surface water treatment devices to measure the pollutant capture and retention capability of their device and to declare these capabilities as they offer their product for sale on the UK market. The Code of Practice was developed due to a lack of a suitable standard test in the UK. Approval and certification under this Code of Practice now allows manufacturers to demonstrate that their published capture and retention capabilities have been tested with appropriate evidence, confirmation from an independent testing aody, and relevant test data. This adopted philosophy allows designers and approvers to apply a risk-based approach, based on the type of application, to minimize the environmental impact of diffuse pollution associated with runoff. The declaration of capture and retention capabilities for a variety of pollutants will now allow regulators, designers, specifiers and local authorities in the UK to select the most appropriate treatment device for the treatment of contaminated surface water in different situations.

Many developing countries have yet to take measures to manage domestic and industrial wastewater. National standardization bodies can support development of pollution standards or promote existing standards targeting effluent discharges, pesticides and other diffuse pollutants from agriculture and industry in the aquatic and natural environment, which may enter into the design of effluent charges and other regulatory instruments for pollution control.

3.3 QI and Water Conservation

Freshwater is an invaluable resource, and in order to ensure that there is enough water for people, the economy and the environment, water resources must be managed in a sustainable way. SDG 6 provides specific targets related to water conservation, calling for increased water-use efficiency, integrated water resources management, protection and restoration of water-related ecosystems. An important contribution to water conservation from the implementation of a QI is associated with the efficient use of water. Metrology, standards, accreditation and conformity assessment activities that support increased water efficiency cover three broad areas:

- **equipment** - design, manufacturing, installation and operation of water efficient devices for various uses i.e. irrigation, domestic use/drinking water, and industrial applications
- **water management** - criteria and good practices regarding the use of water in a variety of contexts and the provision of water services by utilities (for drinking water, wastewater and storm water)
- **water footprint assessment -** methods and tools for assessing the 'water footprint' of a product, i.e. the volume of freshwater used to produce a product or service, measured over the complete supply chain

Another contribution to water conservation from a QI concerns the re-use of water. There are substantial opportunities for re-using water in almost all sectors. Metrology, standards, accreditation and conformity assessment activities support the re-use of water re-use by providing methods, tools to support all the operations involved in the collection, processing, storage, distribution, consumption, drainage and other handling of wastewater, and treated effluent to ensure compliance to the quality requirements for various purposes (e.g. irrigation, industrial use, drinking water).

4. The Way Forward

Access to safe water and sanitation are basic human rights. The responsible use of freshwater is also vital in the support of economic activities and to achieve healthy and satisfactory standards of living. This is clearly recognized by SDG 6, which calls for profound transformations of the way water resources are currently used and managed. The challenges are great. Even more so for countries which have to create infrastructures providing services similar to those available in more developed countries, while at the same time coping with the conditions and problems related to water in the 21st century.

A QI is indispensable in supporting the effective and efficient implementation of regulatory frameworks and other measures regarding the provision of water and wastewater treatment. Improved access to safe water and sanitation can provide a significant economic advantage both in terms of reducing impact on the health care system and strengthening development.

Managing water sustainably requires that governments have suitable programmes in place to accurately measure and reliably monitor national water resource usage. Sources of pollution also need to be identified and monitored using suitable metrics. Both of these activities need to be supported by the availability of appropriate metrology infrastructure and analytical and test capabilities to ensure the production of trusted and traceable data that is internationally comparable.

Industrial wastewater treatment requires special attention due to the inherent technical complexities and the possibility of obstacles due to economic and / or political pressure. Appropriate partnerships and collaboration with regional and international organizations, and support from development agencies are approaches that could to be pursued in seeking appropriate remedies.

UNIDO contributed to a more adequate, effective and sustainable national QI in Malawi, in accordance with international and regional principles and practices. One aspect of this support was to enhance the performance of the Malawi Bureau of Standards (MBS) for conformity assessment services. As a result, the Physics and Biochemical Science Department, University of Malawi, and the Polytechnic, Blantyre, made an independent assessment of the MBS laboratory to determine its compliance on bottled water testing and the findings were submitted to the MBS between September and October 2018. The key finding was that the MBS water testing laboratory is in compliance with most of the requirements of ISO/IEC 17025:2005.

6. PROTECTING THE PLANET

6.1 Climate Action

SDG 13 - Take urgent action to combat climate change and its impacts.

SDG 13 calls for broad international cooperation in building resilience and adaptive capacity to the adverse effects of climate change, developing and implementing long-term low emissions development strategies, and accelerating the reduction of global greenhouse gas emissions for example through sustainable energy solutions and the uptake of resource-efficient technologies and practices, and cleaner production in industrial processes.

As countries respond to this urgent call to scale up climate action, the institutionalization of data and data management including aspects such as the transparency, completeness, accuracy and credibility of data has gained pertinence. Building on existing data and data management systems and infrastructure is key to responding urgently to climate change. Therefore, identifying and integrating the role of the national and regional QI infrastructure into national and regional climate change policies and associated implementation plans can assist countries and regions in effectively managing climate change data and reporting, leading to improved transparency, education and enhanced climate ambition. The support provided by a QI, including reliable data, can ensure continual improvement and appropriate focus in the design and implementation of climate actions and create the insights needed for effective climate policy development and integration into national sustainable development planning and implementation activities. For example, national and regional QI infrastructure could inform climate change policy with insight into synergies and trade-offs with aspects such as job creation, economic trade and industrial development, and standards and regulations.

1. Climate Change and Economic Growth

Increases in global temperature are expected to result in the raising of sea levels, increases of extreme and unpredictable weather events (such as record draughts in certain areas, massive and concentrated rainfall in others, more frequent and stronger hurricanes) and the overall modification of the subsistence conditions of a large variety of eco-systems. Without adequate mitigation, climate change will impact the life of billions of people by increasing water scarcity and amplifying the pressure on agriculture and food production. It is also going to disrupt economic development, with disproportionate impact on the most vulnerable countries, due to the increased frequency of extreme weather events, which trigger natural disasters with associated losses and costs of recovery. In the longer term, irreversible transformations driven by climate change may contribute to modifying the Earth's systems so profoundly that even human civilization is challenged.

Scientists have reached an overwhelming consensus[47] on the causes of climate change, understanding that today it is primarily determined by greenhouse gas (GHG) emissions generated by human activity.[48] Such activity includes industrial and other development related to economic growth. Mitigation of, or adaptation to, the effects of climate change are both critically dependent on how current and future economic activities including industrial, agricultural and infrastructure development, and the use of land and waters can be transformed to become more 'climate friendly' and 'carbon neutral.' However, this is not an easy task. Jeffrey Sachs, one of the leading world experts on sustainable development,[49] notes that "There has never been a global economic problem as complicated as climate change. It is simply the toughest public policy problem that humanity has ever faced."[50] He also notes that GHG emissions are at the core of the entire world economy. Industrial societies have developed based on fossil fuels and therefore this makes it very difficult to take serious, impactful measures. He also stresses that "the energy sector is the home of the most powerful companies. By and large, these companies hope, plan and lobby for the world to remain heavily dependent on oil and gas, despite the risks to ourselves and future generations."[51]

2. Challenges and the Achievement of Transformational Needs through the SDGs

A climate change synthesis report published in 2014 by the Intergovernmental Panel on Climate Change (IPCC) indicates that in order to avoid the worst consequences of climate change, increases in global temperatures should be limited to below 2°C, while making the best efforts to stay within 1.5°C above pre-industrial levels. This is the essence of the historical Paris Agreement, reached at the Conference of the Parties of the UNFCCC (COP 21) in 2015. In order to strengthen the global response to the threat of climate change, the agreement (Article 4, paragraph 2) requires each party (country) to prepare, communicate and maintain successive nationally determined contributions (NDCs).[52]

Collectively, three post 2015 agendas for action provide the foundation for sustainable, low-carbon and resilient development under a changing climate, namely the Paris Agreement, the 2030 Agenda for Sustainable Development and the

[47] See IPCC (2014) Climate Change 2014 Synthesis Report, IPCC Geneva.
[48] See articles referred to, Available at: https://earthobservatory.nasa.gov/Features/CarbonCycle and http://www.bgs.ac.uk/discoveringGeology/climateChange/general/carbonStory.html
[49] Special adviser to the United Nations (UN) Secretary-General António Guterres on the Sustainable Development Goals (SDGs), professor at Columbia university, and director of the Earth Institute at Columbia.
[50] The Age of Sustainable Development, Columbia University Press, 2015.
[51] Ibid.
[52] Details about NDCs. Available at: https://unfccc.int/process/the-paris-agreement/nationally-determined-contributions/ndc-registry

Sendai Framework for Disaster Risk Reduction.[53] Achieving the primary goal of the Paris Agreement, to keep the average global temperature rise well below 2°C degrees and as close as possible to 1.5°C above pre-industrial levels, is vital to the achievement of all three of these agendas. A global transition towards a low-carbon economy is therefore required and needs to be pursued by individual countries as well as through various forms of international cooperation. The type of actions required, which would need the support of an appropriate QI can be found in Section 4 - Mitigation of Climate Change and Adaptation to Climate Change below. It is also important to emphasize that such actions should be considered and implemented within the framework of many of the other SDGs.

Mitigation of Climate Change

» *Aggressive energy efficiency programmes*. Rapid progress can be achieved by increasing efficiency in all areas of energy consumption, reducing the carbon footprint of a large variety of activities.

» *Substantial increase of generation from renewable energy sources. The promotion of alternative sources of renew*able energy such as solar, wind, hydroelectric, geothermal and biofuels. With the improvement in performances and reduction of cost of renewable energy sources, many are becoming a much more cost-effective alternative when all factors are considered.

» *Fuel shift*. The increased transition to electric motors, use of electrical appliances and other devices to replace existing use of fossil fuels (e.g. internal combustion engines, industrial furnaces, gas appliances) should be actively pursued together with the development of suitable infrastructure supported by low-carbon energy sources.

» *Waste management*. Municipal and industrial waste are significant sources of carbon emissions, and therefore it is imperative to reduce waste and harness latent energy in subsequent treatment.

Adaptation to Climate Change

» *Agriculture and food production*. Issues to be addressed include soil protection and more efficient water usage.

» *Urban planning*. Climate change should be considered a key element of future city planning, leading to more climate resilient cities, for example, to modify / adapt building codes for the emerging climate conditions.

» *Regulations and standards*. Mandatory requirements in the form of regulations and associated compliance monitoring mechanisms should be introduced and enforced in a variety of critical areas. Voluntary standardization should be supported and promoted by public authorities wherever relevant.

[53] The Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) is the first major agreement of the post-2015 development agenda, with seven targets and four priorities for action. It was endorsed by the UN General Assembly following the 2015 Third UN World Conference on Disaster Risk Reduction (WCDRR).

3. The Role and Application of QI

Measuring climate-related variables is of fundamental importance in order to understand and monitor climate change. There is also a need to evaluate the ongoing impact of human activities and the policies, programmes and projects aimed at achieving climate mitigation and/or adaptation. The need for scientific observations of ever-increasing complexity and accuracy is placing ever stringent demands on the precision and traceability of measurement results to internationally agreed units of measurement. Among the issues currently being addressed in this domain are:

» Calibration of instruments (sensors and other equipment).

» Standards and guides for climate data management (including data capture, storage, processing, exchange, presentation and quality control).

» Tools and approaches for data analysis and modelling.

There are also a variety of important emerging issues also being addressed including:

» Standards and comparisons for atmospheric composition, to ensure the long-term stability and reproducibility of reference materials, and explicitly defined calibration scales and their SI traceability.

» Ultra-sensitive, SI-traceable measurement techniques for measuring the amount-of-substance of greenhouse gases.

» Development of suites of SI-traceable, amount-of-substance, primary gas standard mixtures for key greenhouse gas species with low uncertainties.

» Consolidation of the metrology infrastructure to enable SI-traceable radiometric calibration of satellite sensors at uncertainty levels relevant for monitoring the Earth's climate.

» Leveraging and expanding the use of tools and approaches for data analysis and modelling within the metrology infrastructure, from aspects such as air quality monitoring to other aspects of climate change.

The World Meteorological Organization (WMO) actively engages with QI institutions addressing standards and conformity assessment practices for measurement in meteorological and climate science through the Commission for Instruments and Methods of Observation (CIMO). Complementing the work of WMO's CIMO there is increasing cooperation with the international metrological community through the BIPM and National Metrology Institutes (NMIs). This cooperation combines the unique expertise of these two scientific communities in developing and strengthening the use of metrology for meteorology purposes and for the climate community as a whole.

Direct measurements and calculation models are increasingly being used to obtain more precise quantifications for different types of activities, for

example the calculation of the actual GHG emissions of a manufacturing plant. The evaluation of GHG emissions, including those from individual organizations, is fundamental to achieve the Paris Agreement goals requiring widespread engagement of businesses and society. Trusted GHG emissions data from organizations are therefore required to:

» Support the implementation and enforcement of relevant public policies.

» Support organizational management in defining and implementing their climate change strategy as an integral part of a corporate sustainability strategy.

» Accurately inform customers and stakeholders about the organization's emission-related performance and associated plans.

On the same subject, GHG emissions data for projects are also important, especially in relation to:

» Initial and ongoing financing for climate action.

» The issuance of credible carbon credits in offsetting their emissions.

GHG reporting, the disclosure of data on the impact of an organization's activities, has to be complete, consistent, accurate and transparent. Inaccurate reporting would result in misunderstanding the depth and extent of GHG emissions and their reductions and an inability to track progress in emission reductions over time - all of which have an impact on trust. As such, information has become increasingly important to investors for managing risk, or making operational improvements, and GHG emissions validation and verification have played a decisive role in ensuring that systems are sound and data are accurate.

Other roles of QI organizations in this activity include

» The development and dissemination of standards, particularly international standards, increasingly used as a reference for methods and processes aiming at detecting and quantifying GHGs e.g. ISO 12039:2001 SO 14064 and ISO 14065.

» The accreditation of laboratories and other conformity assessment bodies involved in measuring GHG, undertaking audits of organizations, or projecting GHG emissions.

» Conformity assessment procedures concerning quantification and reporting of GHG emissions and removals by individual organizations, projects, industry sectors or cities.

The innovative use of metrology, standardization, accreditation and conformity assessment can also help:

» Foster the development and broad dissemination of new technologies / products, e.g. the renewable energy solutions that are essential to support the transition to a low-carbon economy by establishing performance requirements, quality control / assurance practices, strengthening the quality of products and enhancing user confidence.

» Develop improved frameworks, based on the rigorous assessment of GHG emissions for different types of activities that support policy makers and business leaders in designing and implementing national strategies for green growth and related economic development including green procurement, and introducing incentives to promote low-carbon activities.

At the twenty-first session of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) climate change conference held in Paris in 2015, the Swedish Minister of Trade highlighted how standards and certification can be used in tackling even the most complex issues. He emphasized how specific standards can deal with definable issues such as measuring GHG emissions (ISO 14064 and ISO 14065), through to generic standards such as ISO 14001 helping to embed the right culture in organizations to help them tackle key issues.

4. The Way Forward

Developing capabilities in understanding, measuring and monitoring climate change is vital to achieve the SDGs, especially SDG 13. This requires strong and well-functioning QI institutions and capabilities to support the measurement of carbon emissions, both emissions from existing activities as well as the data required for reliable forecasts from development projects. This is critical in the assessment of the true value of economic activities and development.

UNIDO is contributing to the sustainable transformation of industrial energy usage practices in Ukraine, by putting in place energy management systems (EnMS) and the methodology of Energy Systems Optimization (ESO), along with the introduction and promotion of the Energy Management Standard ISO50001. The demand for energy efficient services are being stimulated through the formulation and implementation of enabling policy and regulatory frameworks for EnMS and ESO adoption, and the creation of the necessary institutional capacity to implement programmes on EnMS, awareness raising, energy audits and demonstration projects. The adoption and promulgation of a national EnMS standard, along with supporting standards, compatible with ISO 50001, will deliver substantial and sustainable energy savings within industry and beyond the industrial sectors of Ukraine.
See: https://open.unido.org/api/documents/13231416/download/Project%20Brief%20Ukraine_EN_120321.pdf and http://www.reee.org.ua/en/proekt-yunido-z-enerhomenedzhmentu-oholoshuje-konkurs-vakansij/

The ability to accurately measure, and reliably forecast, carbon emissions is also an essential component of well defined, reliable and trusted project submissions for accessing climate funding. This is a fast-growing component of the global financial market, supported by institutions such as the World Bank, development agencies and private sector ventures. This is also an important aspect of the UNFCCC mechanisms and of the Paris Agreement.[56] Whilst the resources available today are currently below what was envisaged by the Paris Agreement, it is expected that they will grow significantly in time. Countries with sound policies, realistic, and well justified plans and projects for low-carbon development, based on trusted data and backed by an appropriate QI will have a competitive advantage in relation to climate funding. The same considerations apply for carbon offsetting projects. The planned new phase of the ETS market in the European Union (Phase 4, covering 2021-2030), the new mechanisms introduced by other countries for carbon pricing, and an increasing interest in voluntary commitments by companies all over the world, is likely to increase the number and value of projects for carbon offsetting. An appropriate QI and fit-for-purpose QI services supporting climate-related action will certainly provide a competitive advantage to those countries that prioritize capacity building in this area.

6.2 Responsible Consumption and Production

SDG 12 - **Ensure sustainable consumption and production patterns.**

SDG 12 promotes green industries, resource efficient management, cleaner production, energy efficiency in industry, reduction of waste and pollution, and environmental sustainability policies in industrial production and consumption, such as the circular economy approach. The goal is structurally interconnected with SDG 7 (Energy), SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities) and has evident impacts also on SDG 13 (Climate Action), SDG 14 and SDG 15 (Life below Water and on Land).

SDG 12 is a call for a profound transformation of existing production and consumption patterns. The goal is to achieve a better quality of life, which certainly includes the availability of goods and services, but in a form very different from that of today. This will require a substantial reduction of the ecological footprint of economic activities (i.e. consumption of raw materials and energy, and pollution into the environment). This can only be achieved by the availability of a fit-for-purpose QI that provides internationally harmonized and agreed guidance, trusted measurement traceability as well as test and inspection data together with the trusted monitoring and CA processes required.

1. Sustainable Consumption and Production and Economic Growth

It is undeniable that an abundance of products and vastly increased consumer choice have contributed to human well-being. However, it is also clear that the way in which this has been achieved, and continues to be pursued, is the primary cause of the key challenges that the world is facing today. Economic development so far has been directly and strongly correlated with the use of materials. In 1900, the world consumed 7 billion tonnes of primary materials. In 1970 materials consumption increased to 26 billion tonnes and by 2017 it reached 90 billion tonnes. By 2030, primary material use is expected to reach 120 billion tonnes and by 2050 up to 186 billion tonnes, if current trends continue.[57] The most important trends[58] that have characterized the use of materials since 1970 are:

- A threefold increase in the absolute consumption of materials (with global per capita average of material use grown from 7.2 tonnes in 1970 to 11.8 tonnes in 2017).
- A change in the mix of materials used, reflecting the evolution and differentiation of economic activities, with the highest increase concerning non-metallic minerals (such as sand, gravel and limestone), the share of which increased from 34% in 1970 to over 47% in 2017.
- A change in geographical distribution and relative growth trends, with Asia-Pacific now accounting for close to 60% of global material consumption (compared with 25% in 1970).
- A significant increase of the burden of material extraction and transformation to low-income countries, e.g. North America and Europe have decreased their domestic material consumption (DMC)[59], but substantially increased the proportion of raw material equivalents (RME) of trade flows, i.e. the amount of primary raw materials required along the supply chain to produce the commodities that they import.

[56] The Global Environment Facility (GEF) has served as an operating entity of the financial mechanism since the convention's entry into force in 1994. At COP 16, in 2010, parties established the Green Climate Fund (GCF) and in 2011 also designated it as an operating entity of the financial mechanism. In addition to providing guidance to the GEF and the GCF, parties have established two special funds—the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), both managed by the GEF—and the Adaptation Fund (AF) established under the Kyoto Protocol in 2001. At the Paris Climate Change Conference in 2015, the parties agreed that the operating entities of the financial mechanism – GCD and GEF – as well as the SCCF and the LDCF shall serve the Paris Agreement.

[57] UNEP and IRP data and reports.

[58] Detailed information can be found in the IRP-UNEP 2017 report "Assessing global resource use: A systems approach to resource efficiency and pollution reduction."

[59] DMC measures the total amount of materials used by an economy. It is defined as the quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports. UNEP-IRP 2017, Resource Efficiency: Potential and Economic Implications.

» A decline in material productivity (i.e. economic output per unit of materials) after the year 2000.[60]

» A substantial increase of waste as 2 billion tonnes of municipal solid waste are produced annually,[61] along with 7 to 10 billion tonnes of waste generated by commerce and industry and construction and demolition activities. These amounts are expected to further increase in the coming years, due primarily to population growth and urbanization trends in emerging and developing economies.

Consumer spending reached a staggering 64% of global GDP in 2017[62] and a significant part of the GDP investment component is also directed to build the capacity to produce consumer goods in the future. Today's mainstream economic model, consolidated and expanded in the second half of the 20th century, is centered on the provision of an ever-growing flow of goods and services, which need to be rapidly consumed and replaced by new products and services, in an upward, accelerating spiral. Some of the consequences of the current mode of economic activity are:

» Continual increase of greenhouse gas emissions and of global world temperatures.

» Reduction of the environment's ability to absorb carbon (due to various causes, including notably deforestation and ocean acidification).

» Significant land and soil degradation (leading to a reduced land base available for food production).

» Substantial loss of biodiversity (which translates in alarming reduction of the biosphere's resilience).

» Increased pollution of cities and habitats (such as rivers, lakes and rural environments) vital for human life and well-being.

One of the most striking, paradoxical aspects of the required transformation promoted by SDG 12 is the potential to also create enormous economic opportunities. New businesses will be required, and many benefits, including the creation of new jobs, can be expected to accrue, especially for those countries and organizations that seize the opportunity and are able to initiate large-scale implementation.

2. Challenges and the Achievement of Transformational Needs through the SDGs

There are four aspects at the core of production and consumption patterns addressed by SDG 12. These are:

» The extraction and use of materials as a primary input to the world economy.

» How products (and services) are used, and how products are disposed of.

» The use of hazardous substances in products and production processes.

» The ability of the environment (air, water and land) to absorb waste and to cope with the other impacts of human activities.

These can be further consolidated under two broad topics - the availability of natural resources on the required scale, and the disruption of the environment, impact on human health and on living conditions. Regarding the first topic, the issue is not so much related to the availability of resources. Whilst there are important exceptions, most materials are still relatively abundant on our planet. The immediate concerns include the scale of the investment required for production, the declining quality of the sources from which materials can be extracted and the increasing environmental and social disruption linked to materials extraction. A clear example of this is hydrocarbons. The complexity, cost and energy return[63] of oil and gas extracted from ultra-deep-water tar sands and fracking, as compared with conventional oil and gas extracted from fields in Texas or Saudi Arabia, show huge and increasing gaps. These disparities can only be maintained because of market dynamics and subsidies and similar trends are evident in several essential metals.[64]

The continuing disruption to the environment related to materials extraction coupled with the continuing increase in their use is not sustainable. In a summary for policy makers, a UNEP-IRP publication[65] states: "Improving the well-being of people while minimizing resource use and environmental impacts, in particular through enhanced resource efficiency, is an essential aspect of delivering on Sustainable Development Goal 12 on responsible production and consumption, and also on almost all of the goals in a direct or indirect manner." This requires decoupling economic growth from resource consumption and environmental impact. Such decoupling could be achieved by:

» Reducing the material/energy intensity of economic activities and reducing emissions and waste from extraction, production, consumption and disposal.

» Promoting a shift of consumption towards goods and services with lower energy and material intensity, without compromising quality of life.

Although they are not easy, such approaches are feasible. They require the use of existing, commercially available, technologies combined with insightful and forward-looking policies and implementation plans together with appropriate organizational and management approaches. Such coordinated and substantial efforts can unlock huge rewards. There is growing evidence of the considerable opportunities and economic benefits that accrue due to developing and introducing measures that increase resource efficiency. These are almost always associated with process improvements and

[60] This is due to a shift in the share of global output from highly material productive economies to less productive emerging economies and is linked to the emergence of global supply chains and the development of infrastructure for urbanization and industrialization by developing countries.
[61] Global Waste Management Outlook, 2015.
[62] Estimate of TheGlobalEconomy.com, based on World Bank data.
[63] Energy returned on energy invested (EROEI or ERoEI); or energy return on investment (EROI).
[64] See e.g. Ugo Bardi, Extracted (2015).
[65] Assessing global resource use: A systems approach to resource efficiency and pollution reduction, IRP-UNEP 2017.

cost-savings derived from increased productivity, the reduction of material inputs and wastage. In addition, increased resource efficiency often results in improved corporate performance and competitiveness, helping to deliver more value to customers and increased consumer satisfaction.

Another strategic direction concerns the transition from the current linear economic model, characterized as "take-make-waste", to a circular economy. A circular economy has been defined as "restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. The circular economy is a continuous, positive development cycle that preserves and enhances natural capital, optimizes resource yields, and minimizes system risks by managing finite stocks and renewable flows. A circular economy works effectively at every scale.[66] " There is also a relatively recent British Standards Institution (BSI) standard that provides a guide for organizations wishing to implement these principles.[67]

As highlighted by Braungart and McDonough[68] , there is no waste in the biosphere: every "waste" generated by living systems is processed and re-used as nutrients by other organisms. According to them the "technosphere" (i.e. the domain of the structures and artefacts created by human activities) can be organized in a similar way. The creation of "technical-nutrients" (raw materials and product components) for assimilation into goods and structures that provide the required functions over a period of time. Following several cycles, these could then be re-used to build other types of goods, that can finally be returned or harmlessly absorbed by the biosphere. This requires a deep rethinking of economic activities, the promotion of innovation aimed at designing appropriate products and systems and also developing new business models based on this paradigm.

The objective of the Resource Efficiency and Cleaner Production (RECP) programme and RECPnet is to improve the resource productivity and the environmental performance of industrial businesses, and to contribute to sustainable industrial development and sustainable production and consumption. Preventive environmental strategies, supported by a fit-for-purpose QI, are adopted to develop and monitor processes, products and services, in order to increase efficiency and reduce risks to humans and the environment. The primary objective of RECPnet is to contribute to the effective and efficient development, application, adaptation, scaling up and mainstreaming of RECP concepts, methods, policies, practices and technologies in developing and transition economies. These activities cannot be undertaken with any confidence in the absence of suitable QI support that is critical in the development and implementation of such initiatives.

[66] The Ellen MacArthur Foundation. Available at: https://www.ellen-macarthurfoundation.org/

[67] See BS 8001:2017, Framework for implementing the principles of the circular economy in organizations – Guide.

[68] Braungart M and McDonough W, Cradle to Cradle, 2002.

3. The Role and Application of QI

The Government of Jordan issued a decision in 2015 that requires all environmental consultation offices to be accredited for all testing and measurement services. This is to improve the confidence in environmental data submitted to the Ministry of the Environment. Environmental audits and impact assessments are not accepted by the ministry unless they are performed under an appropriate scope of accreditation.

Accurate information is the foundation for sustainability policy and for the virtuous, eco-friendly behaviour of the key parties concerned. This requires capturing and monitoring data on the amount of materials, energy, water and land used. It also requires data on the emissions and waste generated by extraction of materials, production processes and product usage. Technical regulations and mandatory requirements can be indispensable for obtaining reliable information about waste, including hazardous waste. Compliance with technical regulations, mandatory requirements and appropriate voluntary standards, as demonstrated through accredited testing, inspection and certification, can also provide the information required to assess and improve the ecological performance of materials and products. They can also provide invaluable support in the determination of the resource efficiency of products and systems. These instruments are also important in the support of public policies. Examples include but are not limited to:

» *Technical regulations* covering maximum pollution / emissions for given substances, restrictions of the use of particular substances or quantity of materials, mandatory use of equipment, type and quantity of wastes. Metrology, standards, accreditation, testing, inspection and certification assist by providing consistent definitions, accurate characterization of substances and materials, test methods for measuring and / or detecting substances, and trusted data on characteristics and performance. The role of reference materials is also critical in maintaining and improving the quality of the physical, chemical and biological measurements that are required to control product properties and to monitor environmental, health and safety parameters (see box below).

» *Economic mechanisms and incentives* such as pollution taxes, use charges or cap and trade mechanisms, as well as subsidies (direct contributions, tax breaks, etc.) for using desirable technologies or processes, green procurement, i.e. giving preference in public procurement to products and services that are deemed to be eco-friendly or 'sustainable' (taking into account environmental and social aspects). Here standards and CA procedures help by providing objective ways to define and assess the ecological performance of products and, in a number of cases, social impacts across the value chain.

» *Regulations or other mechanisms* aiming to drive the development of new generations of products in given sectors. The EU Ecodesign Directive – which sets out minimum mandatory requirements for the energy efficiency of certain categories of products and helps drive their performance improvement over time is an example of this approach.

Accurate measurements are an essential feature both of everyday life and economic activity. For many tests, a laboratory instrument is calibrated using a reference material (RM) i.e. substances with specific, defined characteristics that serve as a comparative value for analyses. The quality of reference materials is critical for accuracy and comparability of analysis results. There are many organizations producing tens of thousands of reference materials worldwide with different levels of purity. Only a sub-set of them provide the highest-quality, certified reference materials (CRMs), which serve as primary references. Many others provide working level reference materials, along with materials prepared in-house, usually called 'quality control materials' which ensure the accuracy of millions of measurements made daily by private and public laboratories. The field is experiencing significant, continual evolution characterized by the development of new RMs and of new techniques and instruments. These meet the growing demand for advanced materials, sustainability requirements, and the need to detect accurately hazardous and toxic materials, including those that are extremely dangerous, even at low concentrations.

An important development concerns the quality improvement of "secondary raw materials", i.e. materials recovered at end of use cycles that are suitable for recycling. These require standards for defining characteristics and properties of such materials, along with the appropriate test methods and laboratory and inspection processes required to determine that they meet expected quality levels. Another is the technical support for eco-friendly products, addressed, for example by Environmental Technology Verification (ETV) programmes. The objective of an ETV programme is the provision of a credible, reliable and independent verification of the performance of environmental technologies i.e. technologies that either result in an environmental added value or that measure parameters that indicate a positive environmental impact. Accredited certification supported by laboratory testing and inspection against international standards such as ISO 14034,[69] ISO / IEC 17025[70] and ISO / IEC 17020[71] prove useful in this regard.

Incredible results can be achieved when there is alignment of objectives, consistent policies and coordinated behaviours of the various concerned parties. Norway, for instance, has achieved a 97% recycling rate for plastic bottles, through a combination of actions including consumer awareness, a deposit scheme (consumers have to pay a deposit for plastic bottles that is redeemed when they return them to collection points) and an environmental tax on plastic producers which can be reduced the more they recycle.

4. The Way Forward

National QI organizations, and their regional and international collaboration networks, provide indispensable support for the transformation of the production and consumption patterns required to achieve SDG 12. The effort required to establish or further strengthen the national QI-related metrology, standards, accreditation and the competent and trusted testing, inspection and certification required to support this goal should be given adequate attention and priority by policy makers. It is also important to note that eligible countries can also be supported in this effort by international development agencies, such as UNIDO. Attention should be directed and concentrated in four strategic directions, especially for developing and emerging economies. These include:

» Appropriate choices that need to be taken now regarding essential infrastructure (energy, buildings, transportation, water supply, sanitation and waste management) and food supply. Planning and implementation should be based on long-term perspectives, considering as critical factors such as the conservation of resources, factoring in environmental and social costs and technology trajectories which are especially important when certain technologies are evolving at an exponential rate.

» A new mind-set needs to be adopted by public authorities, the private sector and citizens. This entails a clear and sustained focus on reducing the inputs of materials into products, the re-use of products and product components, the recycling of materials and the minimization, appropriate treatment and responsible disposal of waste, especially toxic waste. Seizing the opportunity to avoid the industrialized countries' consumerist economic model, governments, business leaders, sensible media and communities should work together to promote and reward a consumption model which departs from the short-term possession of goods and leverage alternative values of local cultures and communities with the opportunities offered by new technologies and business models.

[69] ISO 14034:2016 Environmental management -- Environmental technology verification (ETV).
[70] ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.
[71] ISO/IEC 17020:2012, Conformity assessment — Requirements for the operation of various types of bodies performing inspection.

6.3 Life on Land and Life below Water

SDG 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development and

SDG 15 - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and biodiversity loss.

SDG 14 supports efforts to reduce the detrimental industrial impacts on water bodies through sound water management methodologies and system introduction, and strategic partnerships to protect coastal and maritime habitats and ecosystems. It also helps to improve fisheries' incomes by encouraging regional cooperation, capacity building and technology, etc. SDG 15 aims at improving rural livelihoods, food security and agricultural production in a sustainable manner and promotes technologies that ensure sustainable management of the soils and the generation of highly productive renewable resources, while supporting the adaptation and adoption of resource efficient and cleaner production methods, technologies and systems. These goals can only be achieved by the availability of a fit-for-purpose QI that provides the internationally harmonized and agreed guidance, trusted measurement traceability and test and inspection data together with the trusted monitoring and CA processes required for successful implementation.

1. Biosphere and Economic Growth

SDGs 14 and 15 are most directly concerned with conserving and protecting the biosphere.[72] They are symbiotically affected by remedial actions underpinning SDG 1 and 2 (due to the linkages to Agriculture), SDG 6 (Clean Water and Sanitation), SDG 7 (Energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Sustainable Consumption and Production Patterns) and SDG 13 (Climate Action). The biosphere is a primary source for human well-being and indispensable for human survival. The Millennium Ecosystem Assessment Report[73] "Ecosystems and Human Well-Being" provides a representation of the various types of ecosystem services supporting human well-being. These have been classified across four dimensions:

» *Provisioning services* - the resources provided by ecosystems that can be directly used for human activities – e.g. food, timber, biomass, water, substances for producing medicines.

» *Regulating services* – the regulation of ecosystem processes that provide benefit in a direct or indirect way to human well-being – e.g. climate regulation, water regulation, water and air purification, erosion control, pollination.

» *Cultural services* – the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, recreation, and aesthetic experiences – e.g. spiritual and religious values, knowledge, educational values, quality of social relations, cultural heritage values, recreation and tourism.

» *Supporting services* – those that are necessary for the production of all other ecosystem services. They differ from the other ecosystem services because their impact on people is either indirect or occurs over a very long time – e.g. soil formation, photosynthesis, nutrient cycling.

Given the complexity of the subject and various scientific and cultural perspectives, it is very difficult to quantify the 'value' of ecosystem services or nature's contribution to people. Ecological economist Robert Costanza and other senior researchers,[74] have estimated that the global value of ecosystem services in 2011 to be US$ 125 trillion / yr. Perhaps a valuable comparison is that the world GDP in 2011 was US$ 73 trillion.[75] What is clear is that, in the words of Sir Robert Watson, former co-chair of the Millennium Ecosystem Assessment, "Nature's contributions to people are of critical importance to rich and poor in developed and developing countries alike. Nature underpins every person's well-being and ambitions – from health and happiness to prosperity and security. People need to better understand the full value of nature to ensure its protection and sustainable use."

2. Challenges and the Achievement of Transformational Needs through the SDGs

Life below water and on land is substantially influenced by human activity in a large variety of domains. These include agriculture, mining, energy generation and use, industrial and urban development, production and consumption patterns. While targeted actions for environmental protection and rehabilitation are important, their impact is limited. It is essential that a new integrated approach for economic development is adopted where environmental sustainability, i.e. protecting and nourishing the biosphere, is a key priority. Such a change requires a holistic perspective in national and international planning and development.

2.1 Life Below Water

Due to the absorption of increasing CO2 in the atmosphere, surface ocean acidity has already increased by about 30 % since pre-industrial times. This is a serious matter because:

[72] Encyclopaedia Britannica: "The biosphere is a global ecosystem composed of living organisms (biota) and the abiotic (non-living) factors from which they derive energy and nutrients."
[73] Millennium Ecosystem Assessment, Available at: https://millenniumassessment.org/documents/document.357.aspx.pdf
[74] R. Costanza et al., Changes in the global value of ecosystem services, 2014.
[75] The World Bank.

» Beyond a certain threshold, many marine organisms (e.g. corals, shellfish and plankton) find it difficult to form shells and skeletons, and existing shells become vulnerable to dissolution. These organisms are at the bottom of the food chain and may generate disruption of the ecosystem with a dramatic decline of fish stocks.

» Altering the way marine life process carbon, ocean acidification may seriously impact the 'carbon sink' function (ability to absorb CO2) of oceans, aggravating climate change patterns.

Ocean pollution includes the introduction of harmful substances into the ocean. One of the most important ocean pollutants is plastic.[76] Over 150 million tonnes of plastic waste are in the ocean and at least 8 million tonnes of plastic leaks into the ocean each year. Another substantial pollutant, oil, is the result of marine transportation, oil discharges by ships and platforms and oil spills from land. Organic nutrients from sewage and agriculture and industrial waste including toxic chemicals and minerals are another problem. Each of these pollutants puts increasing pressure on the marine ecosystem and negatively affects vital functions. Particularly alarming are the depletion of oxygen content in water, the disruption of the marine food chain and toxic substances affecting marine species and human health.

According to a FAO report[77] "the fraction of fish stocks that are within biologically sustainable levels has exhibited a decreasing trend, from 90.0 % in 1974 to 66.9 % in 2015. In contrast, the percentage of stocks fished at biologically unsustainable levels increased from 10 % in 1974 to 33.1 % in 2015". Total fish capture peaked in the 90s and has remained stable since then, with aquaculture responsible for all subsequent increases in fish production. Current concerns include:

» The evolution of fish capture [78] which, to maintain volume, is moving towards lower trophic levels (fish closer to the bottom of the food chain) and therefore increasing the number of species fished unsustainably.

» The volume of 'fishmeal' for aquaculture which, if managed unsustainably, contributes to the depletion of the lower trophic levels of fish and other marine organisms, disrupting the food chain (and hence, in the long term, aquaculture itself).

2.2 Life on Land

According to the FAO Global Forest Resource Assessment (2015), "In 1990 the world had 4.128 million hectares (ha) of forest; by 2015 this area had decreased to 3.999 million ha. This is a change from 31.6 % of global land area in 1990 to 30.6 %1 in 2015. "[…] "Between 2010 and 2015 there was an annual loss of 7.6 million ha (natural forests) and an annual gain of 4.3 million ha per year (planted forests) , resulting in a net annual decrease in forest area of 3.3 million ha." The good news was that data showed a significant decrease of the rate of deforestation over time (reaching 0.08% during the five-year period, 2010-2015). The bad news is that the recent data[80] indicates that deforestation[81] in tropical countries surged again in 2016 and 2017, with 15.9 million ha of tree cover lost in 2017 (over 50% in three countries alone, Brazil, Indonesia and the Democratic Rep. of Congo). This trend is alarming as forests have a key role[82] in relation to carbon sequestration. They also provide a wealth of forest products and a number of important ecological and environmental services, such as water purification and erosion control.

Soil[83] is possibly the most fundamental component of terrestrial ecosystems, because it supplies almost all the elements that plants need to support photosynthesis and other metabolic processes. Like water, soil is indispensable to life on earth, yet this invaluable resource continues to be mismanaged and is increasingly under threat. Soil erosion has been significantly amplified by human land change and land use activities (such as deforestation) and mismanaged agricultural techniques (such as intensive agriculture applied in unsuitable areas). According to the World Wildlife Fund for Nature (WWF), half of the topsoil on the planet has been lost in the last 150 years. In addition to a net loss of soil, known as erosion, soil may also suffer from degradation.[84] The Status of the World's Soil Resources[85] report published by FAO in 2015 indicates that "33 %t of land is moderately to highly degraded due to erosion, salinization, compaction, acidification, and chemical pollution of soils. Further loss of productive soils would severely damage food production and food security, amplify food-price volatility, and potentially plunge millions of people into hunger and poverty."

Desertification is the phenomenon that refers to the persistent degradation of dryland ecosystems, land turning into desert, by human activities. Causes include unsustainable farming, mining, deforestation, overgrazing, clear-cutting of land and overexploitation of

[76] World Economic Forum, The New Plastics Economy Rethinking the future of plastics, 2016.
[77] The status of world fisheries an aquaculture, FAO, 2018, Available at: http://www.fao.org/3/I9540EN/i9540en.pdf
[78] Primary factors are: Illegal, unreported and unregulated (IUU) fishing, mismanaged subsidies to fisheries and lack of capabilities and resources to support appropriate fisheries management.
[79] This is another hot topic debated by specialists in the field – i.e. to what extent planted forests are comparable to natural forests in terms of supporting biodiversity and providing ecosystem services.
[80] WRI Global Forest Watch, 2017.
[81] Deforestation is primarily driven by pressure from agriculture (clearing forests for croplands and grazing land). It is aggravated by logging and other unsustainable uses of forests' biomass. These activities are very frequently conducted illegally and escape from governments' control due to lack of resources, low priority in the framework of governments' policies and corruption.
[82] To give an idea, it is estimated that between 1990 and 2015 global carbon stocks in forest biomass have decreased by almost 11 gigatons (Gt).
[83] Soil is defined as "the upper layer of earth in which plants grow, a black or dark brown material typically consisting of a mixture of organic remains (humus), clay, and rock particles."
[84] Defined by the FAO "as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries."
[85] Status of the World's Soil Resources. Main Report, 2015, Available at: http://www.fao.org/policy-support/resources/resources-details/en/c/435200/

water resources. All of which can be further aggravated by draughts and other impacts of climate change. According to the United Nations Convention to Combat Desertification (UNCCD) more than half of agricultural land is affected by some form of soil degradation and 12 million ha of arable land are lost to drought and desertification annually, affecting 1.5 billion people.

The loss of biodiversity affects both terrestrial and marine ecosystems. The WWF Living Planet Index (LPI) measures biodiversity abundance levels based on 14,152 monitored populations of 3,706 vertebrate species. The latest edition of the WWF Living Planet Report (2016) indicates that wildlife populations have already shown a substantial decline, on average 58 % since 1970, and this number is likely to reach 67 % by the end of the decade. The most important factors responsible for the decline of wildlife populations are the loss and degradation of habitats, species overexploitation, pollution, invasive species, diseases and climate change. Biodiversity is an essential feature of ecosystems, contributing to their resilience and productivity.

3. The Role and Application of QI

All of the international agreements, and related national or sectoral programmes, that seek to address issues raised by SDG 14, SDG 15 and many of the other SDGs require significant and increasingly complex efforts. These will require sound management and decisions made using trusted measurements. The monitoring, reporting, and verification activities required to fulfil international treaties and prove compliance with national laws, regulations and voluntary schemas will require substantial contributions from all components of a QI. QI institutions provide an essential contribution in terms of measurement capabilities, formalization of good practices, support to management, monitoring, reporting and verification of compliance through the provision of trusted laboratories and other data as well as inspection and certification reports.

In Scotland, the Scottish Environment Protection Agency (SEPA) is implementing the Regulatory Evidence Strategy (RES) which provides a framework for collecting information about the activities SEPA regulate. The agency has subsequently introduced the Measurement Assurance and Certification Scotland (MACS) scheme. The scheme, which forms part of the agency's better environmental regulation programme, relates to operator self-monitoring. In order to establish a robust quality assurance framework, and to increase confidence in the regulatory decision-making process, the MACS scheme is based on data provided by accredited laboratories that are the United Kingdom Accreditation Service (UKAS) accredited to perform environmental analysis. The scheme covers the entire monitoring process from planning and scheduling to sampling, analysis and data reporting.

In the past 20 years, a multitude of voluntary standards, testing, inspection and certification schemes have been introduced on the market, along with international agreements that address fisheries including aquaculture. They were designed to provide market incentives in terms of preferred market access to promote sustainable fishing and aquaculture practices. According to the FAO, around 14 % of the global production of both captured and farmed fish was certified in 2015- 80 % of the certified fish was from capture fisheries and 20 % from aquaculture. Given the pressure of multinational retailers and trader and consumer expectations, these figures are very likely to increase.

The National Fishing Service in Chile, SERNAPESCA, relies on accredited laboratories and inspection bodies to ensure the safety of seafood. Accredited testing laboratories are required to perform activities such as sampling of seafood products, testing of process water and marine sediments.

Food safety, sustainability standards and related accreditation and conformity assessment practices have a central role in relation to trade policies and access to the international market. The international reference framework includes the Codex Alimentarius standards, the WTO SPS Agreement and codes of practice, and guidance on post-harvest practices and trade.

In the United Kingdom, food assurance schemes help consumers and businesses determine that food has been produced to particular standards. Although these schemes are voluntary arrangements, many are accredited by the United Kingdom Accreditation Service (UKAS) as product certification schemes. As such, they are subject to regular, independent evaluations to ensure that those that are certified are meeting specific standards and often include logos on consumer products to indicate this. Numerous UK businesses, including large supermarket chains, now make certification against a particular assurance scheme a requirement for their suppliers. The UK Food Standards Agency (FSA) also maintains close contact with these food assurance schemes given their ability to promote practices that are compliant with recommended policy. The FSA also monitor whether communications and claims made by assurance schemes are accurate.

4. The Way Forward

Protecting and nurturing life on land and below water is indispensable for people's well-being and from a longer-term perspective, human survival. Although natural resources and ecosystem services provide

enormous benefits, mainstream economic and social systems fail to recognize and integrate their value into core mechanisms and functions at the scale necessary to reverse current trends. These behaviours and trends need to be challenged and addressed. The metrology, standards, accreditation institutions and the conformity assessment service providers for testing, inspection and certification, that are all part of a QI, provide important support to help tackle these challenges. They can also provide the technical support and access to international networks and best practices as a catalyst to develop new technologies or promote the dissemination of good practices.

UNIDO has supported the sustainable development of the seaweed and pangasius value chain in Indonesia, with the overall objective of enhancing market access through improving quality and yield of their products and enhancing productivity and the resource efficiency of the processing industry. As a result, 680 seaweed and pangasius farmers have enhanced their good farming practices. Productivity, traceability and resource efficiency have also been improved. A seaweed traceability platform was established for 6 local processing firms, 1 multi-national firm and 3,000 seaweed farmers. In addition to improving the yield and quality of seaweed that is sold as raw material for industrial processing, the UNIDO project is empowering female seaweed farmers by helping them create alternative sources of income. Around 490 female seaweed farmers have been trained in the processing, packaging and marketing of 19 seaweed-based foods such as seaweed noodles, juice, syrup and biscuits.

7. THE WAY FORWARD

The fulfilment of the SDGs requires a radical change of economic activities, social practices and human behaviour. Requirements for products for instance should no longer be restricted to purely technical aspects (e.g. dimensions or performances) or health and safety provisions. As part of driving change in the future they must increasingly include environmental foot-print aspects related to full product lifecycles, aiming at eliminating or carefully controlling toxic substances, at minimizing the use of raw materials (e.g. through modularity and extensive re-use of components across the life cycle), at minimizing energy consumption (for both production and use), at reducing and ideally eliminating waste (e.g. through a longer duration of products, re-use of components and recycling of materials) and at abating carbon emissions through the life cycle.

National and regional quality infrastructure (QI) institutions, and the metrology, standardization, accreditation, testing, inspection and certification services they provide and enable, can continue to play a fundamental role in supporting the transformation required. Countries differ in their QI priorities and capacities and in a large number of countries the QI has evolved over many years, often in an organic, unstructured way. In many countries, QI institutions now need to be strengthened and expanded to meet the SDG-related challenges and opportunities ahead. The SDGs can also provide the impetus necessary for the development of solutions that also fit into the broader context of regional integration and the alignment of the QI system with international and regional TBT, SPS and TFA-related processes and coordination activities.

Establishing an appropriate quality policy (QP) and the associated QI system can substantially assist nations in driving the required change while also positioning their economy to seize the many opportunities available through appropriate and holistic implementation of the SDGs. Strategic partnerships and international industrial cooperation have proven to be innovative and impact-maximizing approaches to address the multidimensional context of economic deprivation, social inequality, and environmental degradation. Any response to achieve poverty eradication and sustainable development – the overarching goal of the new development agenda – will need to consider these approaches if it is to be successful.

Many good practices have evolved related to QI systems that support the SDGs whilst simultaneously underpinning trade and protecting the safety and health of people, fauna and flora and the environment. Some of these practices are contained within the WTO TBT, SPS and TFA Agreements, while others reside in the mandatory and other requirements of international recognition arrangements of organizations including those of the members of INetQI (e.g. ISO, IEC, ITU, BIPM, OIML, ILAC and IAF). These, together with the new requirements embedded in standards, regulations, codes of practice and other elements of a QI, can help consumers make informed choices, encourage innovation and, lead businesses and industries to take up appropriate new technologies and organization methods improving current practices, and support public authorities in designing and implementing public policies aligned with the SDGs.

As a member of INetQI, UNIDO also has an important contribution. The ability of countries to exploit SDG-related opportunities, compete in global markets and to participate in international value chains is often challenged by their difficulties in demonstrating compliance with requirements and rules. UNIDO helps them tackle these challenges by working with them to develop a QP and set up an appropriate QI. Such programmes are two of the specialized services that UNIDO offer among its overall activities to promote inclusive and sustainable industrial development (ISID). This approach offers developing countries and economies in transition opportunities to eradicate poverty and develop sustainably. ISID helps them to build up their industrial base as a platform for social inclusiveness, economic competitiveness, environmental sustainability and integrating with the global trading system. As a first step, UNIDO can offer training to increase understanding of QI and how to get the best out of it. UNIDO's approach is holistic, from building awareness of the QIS to helping to set it up and get it running efficiently and effectively. Throughout, UNIDO emphasizes hand-in-hand and hands-on cooperation with stakeholders on collective actions based on shared objectives.

The information and examples provided in this document are intended to help provide insights and examples of how QI supports and underpins the implementation of the SDGs. It has also provided information of the role of some of the members of INetQI in helping countries address QI-related needs in supporting their SDG strategies. It is hoped that by providing such information, countries will seriously consider, and appropriately address their QI-related needs as they develop national implementation plans that are consistent with national aspirations and the realization of the new global vision.

ANNEX

International QI Organizations and Their Roles

1. Metrology

1.1 International Organization of Legal Metrology (OIML)

The OIML is as intergovernmental treaty organization, whose membership includes member states, that promotes the global harmonization of legal metrology procedures. Originally focused on trade metrology, the expansion in the use by governments of regulatory measurements has seen OIML become increasingly involved in establishing international requirements for a wide range of environmental, occupational health and safety and medical measurements.

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. As an intergovernmental treaty organization, the OIML:

» 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.

» Promotes and facilitates the exchange of knowledge and competencies within the legal metrology community world-wide.

The OIML also administers a certificate system for measuring instruments to facilitate administrative procedures and lower the costs associated with the international trade of measuring instruments subject to legal requirements. The system provides the possibility for a manufacturer to obtain an 'OIML Certificate' and a 'Test Report' indicating that a given instrument type (pattern) complies with the requirements of the relevant OIML 'International Recommendations.' OIML certificates are accepted by national metrology services on a voluntary basis, and the system serves to simplify the type (pattern) approval process for manufacturers and metrology authorities by eliminating costly duplication of application and test procedures.

1.2 The International Bureau of Weights and Measures (IBWM / BIPM)

The International Bureau of Weights and Measures (IBWM / BIPM) is an intergovernmental organization that was established by the Metre Convention, through which member states act together on matters related to measurement science and measurement standards. The organization is usually referred to by its French initialism, BIPM. The mission of the BIPM is to work with the National Metrology Institutes (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.

» To be a centre 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.

» 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.

2. Standardization

2.1 The International Organization for Standardization (ISO)

The ISO is an independent, non-governmental international organization with a membership of 162 national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant international standards that support innovation and provide solutions to global challenges. ISO has published more than 21,000 international standards and related documents, covering almost every economic sector, from technology, to food safety, to agriculture and health care. Its portfolio of standards

includes topics relevant to products and processes, test methods, management systems, conformity assessment topics and others, all of which can make significant contributions to the achievement of many of the 2030 Sustainable Development Goals.

The ISO Committee on Conformity Assessment (CA), ISO/CASCO, is responsible for developing and maintaining a coherent and mutually supportive framework of guides and standards related to conformity assessment, promoting their global acceptance and use, and fostering global recognition of conformity assessment results based thereon. It has issued guidance and reference material covering virtually every aspect of conformity assessment (e.g. testing and calibration, inspection and certification).

The International Electrotechnical Commission (IEC)

The IEC is an independent, non-governmental international organization that brings together 169 countries representing 98% of the world population and 96% of energy generation. The IEC publishes more than 9000 consensus-based international standards that cover all devices and systems that generate or use electricity and contain electronics; covering aspects that are directly relevant to 12 of the 17 SDGs. The IEC also manages four 'conformity assessment systems' that help verify the safety and efficiency of electric and electronic systems and devices. IEC members are national committees (one per country) which are sometimes linked to the National Standards Body (NSB). Each must be fully representative of all national interests in the field of electrotechnical standardization and conformity assessment. The IEC Affiliate Country Programme offers developing countries around the world a unique form of participation without the financial burden of actual membership.

2.2 The International Telecommunications Union (ITU)

The ITU is the United Nations' specialist agency for information and communication technologies - ICTs. It allocates global radio spectrum and satellite orbits, develops the technical standards that ensure networks and technologies seamlessly interconnect, and strives to improve access to ICTs to underserved communities worldwide. Founded on the principle of international cooperation between governments (member states) and the private sector (sector members, associates and academia), ITU is the premier global forum through which parties work towards consensus on a wide range of issues affecting the future direction of the ICT industry. It is based on public-private partnership with a current membership of 193 countries and over 800 private-sector entities and academic institutions. ITU membership represents a cross-section of the global ICT sector, from the world's largest manufacturers and telecom carriers to small, innovative players working with new and emerging technologies, along with leading R&D institutions and academia.

2.3 Other Standards-setting Organizations

The World Health Organization (WHO), Codex Alimentarius, International Plant Protection Convention (IPPC), and The World Organisation for Animal Health (OIE), also create standards. As these are often part of legally binding international treaties (and therefore part of mandatory measures of governments which are signatory parties to those agreements), in TBT terms, they are technical regulations and not standards. Although these 'standards' are primarily concerned with safeguarding human, animal and plant health, conformity with the quality and safety requirements increasingly assists exporters to access international markets.

There are many other, often sector-specific fora where substantial standardization activities that are relevant for international trade are carried out by industry and governments (e.g. chemicals, automotive parts, measurement instruments, pharmaceuticals, transport equipment and requirements for carrying dangerous goods on them, equipment for mineral exploration, pressure equipment, electronic data transmission, digital audio and video). It is important to stress that not all of the standards developed by these organizations can be considered 'international standards' according to the TBT.

3. Accreditation

3.1 The International Accreditation Forum, Inc. (IAF)

The IAF coordinates the accreditation activities related to Certification Bodies (CBs) for management systems, products, services, personnel and other similar programmes. The IAF also manages a Multilateral Recognition Arrangement (MLA) between its qualifying accreditation body (AB) members. The purpose of the MLA is to ensure mutual recognition of accredited certification between signatories to the MLA, and subsequently acceptance of accredited certification in many markets based on one accreditation. The MLA Annual Report, published on an annual basis by the IAF, provides details of the peer evaluation process and aims to ensure that regulators, specifiers, and businesses can have confidence in the arrangement.

3.2 The International Laboratory Accreditation Cooperation (ILAC)

The ILAC is responsible for activities related to the accreditation and recognition of laboratories and inspection bodies. ILAC also promotes practices that facilitate the international acceptance of test and inspection data. Qualifying accreditation body members of ILAC are signatories to its mutual recognition arrangement, the 'ILAC Arrangement', created to promote the international acceptance of accredited test, calibration and inspection data. The aim is increased use and acceptance by industry as well as government of the results from signatory AB accredited laboratories and inspection bodies, including the results from laboratories and inspection bodies accredited by signatory ABs in other countries.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