



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

REBOOTING QUALITY INFRASTRUCTURE FOR A SUSTAINABLE FUTURE



**REBOOTING QUALITY
INFRASTRUCTURE
FOR A SUSTAINABLE
FUTURE**

A woman with dark hair, wearing a white lab coat, is looking intently at a tablet device. The scene is overlaid with futuristic digital graphics, including glowing blue particles, data charts, and abstract geometric shapes in yellow, orange, and red on the left side. The background is a blurred office or laboratory setting with windows and equipment.

DRIVING ECONOMIC TRANSFORMATION

Contents

Foreword.....	8
Acknowledgements.....	11
Disclaimer.....	11
List of Abbreviations.....	14
Speed Read the Essentials.....	16
Executive Summary.....	18
1. Why this Publication is Needed.....	26
2. Overview of Quality Infrastructure.....	28
3. Overview of the SDGs.....	34
4. Building Prosperity.....	38
4.1 Industry, innovation and infrastructure.....	39
4.2 Decent work and economic growth.....	44
5. Meeting the Needs of People.....	52
5.1 Food and agriculture.....	53
5.2 Good health and well-being.....	58
5.3 Affordable and clean energy.....	65
5.4 Clean water and sanitation.....	71
5.5 Gender equality.....	76
6. Protecting the Planet.....	82
6.1 Climate action.....	83
6.2 Responsible consumption and production.....	87
6.3 Life on land and life below water.....	92
7. The Future of Quality Infrastructure.....	98
Annex A: International Quality Infrastructure Organizations.....	102

FOREWORD

UNIDO has a proven track record in developing quality infrastructure (QI) that acts as a force multiplier for the efforts of developing countries to improve their industrial and economic performance as a basis for prosperity, health and well-being. This new publication shares concrete examples of QI success stories from UNIDO member states and our stakeholders around the world.

However our successes should not encourage us to lapse into complacency. It is a wake-up call for all of us with a stake in quality infrastructure: UNIDO and our members and our numerous partners. We hope that this publication will help to provoke a critical rethink of existing QIs, or those under development. QI is a marvellous tool for improving the lives of populations through economic development.. QI needs to evolve – and swiftly – to be relevant in the face of ever more rapid technological innovations and the threats posed by climate change, pollution, diminution of resources and destruction of the biosphere. This publication conveys a call to action for adapting QIs to the impacts of the “Fourth Industrial Revolution (Industry 4.0)”, including artificial intelligence, smart manufacturing, smart energy, smart agriculture and the circular economy.

In addition, QIs must evolve rapidly to help meet increasing societal demands, in particular, for gender equality. Gender equality is a fundamental human right, and is a necessary foundation for a prosperous, sustainable and peaceful world

QIs also have a major role to play in bringing about a new economic paradigm. Many in society are becoming aware of the need to replace the wasteful excesses of consumerism through a circular economy, respectful of resources and aiming for general well-being rather than endless material acquisition. A tremendous shift is taking place in perceptions, from transforming economic growth for its own sake, with its accompanying destruction of resources and the environment, to one that seeks to preserve the environment and to increase prosperity and the quality of life for all.

. Action is needed – and where action is needed, a quality infrastructure can offer an overarching, inclusive and holistic framework for transforming policy into reality on the ground. This publication will give both policy makers and QI professionals ideas

and the path forward for enhancing the ability of QIs to help meet today’s numerous challenges.

At the same time, it is a primer on the role of QIs in achieving inclusive and sustainable industrial development (ISID) and advancing the United Nations’ Sustainable Development Goals (SDGs). QIs contribute to three of the SDG pillars – People, Prosperity and Planet – and the publication illustrates this by examples and case studies. It does not shy away from the challenges faced by developing countries, but explains in practical terms how a robust QI can enable them to overcome the difficulties.

The term, “a quality infrastructure”, refers to 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. A QI:

- » Provides the solid technical and operational foundations indispensable for modern society to function
- » Contributes to policy objectives in areas including industrial development and trade competitiveness in global markets
- » Guides decision-making and good practice for the efficient use of natural and human resources
- » Ensures food safety, health, and the quality and safety of products and services
- » Protects the environment through the sustainable management of natural resources, actions aimed at mitigating climate change, and protecting the biosphere

Contributing to the SDGs and measuring progress in achieving the specific targets of these goals requires robust quality infrastructures with their building blocks in place: standardization, metrology, accreditation, conformity assessment (in particular testing, certification and inspection services) and market surveillance.

A QI ensures that these components work in harmony and avoid the inefficiencies and confusion of overlapping responsibilities and conflicting practices. This is why it is essential for governments to set the lead through a quality policy that promotes a culture

of quality and to establish effective QIs that provide an overarching framework to reform, consolidate, refine and maintain effective quality programmes.

The ability of developing countries and economies in transition to compete in global markets and participate in international value chains is often hampered by their difficulties in demonstrating compliance with quality requirements and trade rules.

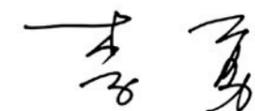
UNIDO helps its member states to tackle these challenges by working with them to set up a QI. It is one of the specialized services that UNIDO provides to promote ISID. This approach contributes to economic development and the well-being of people through the strengthening of a country’s industrial base as a platform for social inclusiveness, economic competitiveness, environmental sustainability and integration into the global trading system.

This publication builds on three complementary brochures published by UNIDO in 2016 and 2017 dealing with the role of standards, accreditation and metrology in the context of the 2030 Sustainable Development Goals.

Among its partnerships, UNIDO, together with the International Network on Quality Infrastructure (INetQI), is committed to promoting and accelerating ISID to enhance the ability of the UNIDO member countries to meet market and societal needs that meet the objectives of the SDGs.

In the future, QI institutions and services will need to be strengthened and expanded to meet new requirements, help consumers make informed choices, encourage innovation and good practice, and lead businesses and industries to adopt sustainable technologies and processes. This will assist public authorities in making a leap forward in defining and implementing policies aligned with the SDGs.

To sum up, this publication is not only a showcase for the good work achieved by the worldwide partnership of UNIDO’s QI stakeholders, but also a call to action to transform QIs for the challenges that lie ahead. The chapters that follow point to the path forward.



Li Yong, UNIDO Director General



ACKNOWLEDGMENTS

This publication has been prepared by the United Nations Industrial Development Organization (UNIDO) under the overall guidance of Mr. Bernardo Calzadilla-Sarmiento, Director of the Department of Trade, Investment and Innovation (TII). Technical inputs were coordinated by Ms. Dominika Dor-Skrobot, Industrial Development Officer (IDO), TII.

The publication is based on the work of Dr. Daniele Gerundino, Dr. Michael Peet and Dr. Barbara Fliess.

We acknowledge the valuable contribution and support of several members of the UNIDO core team: Mr. Steffen Kaeser, Dr. Otto Loesener, Mr. Alejandro Rivera, Mr. Cong Wu, Ms. Dorina Nati, Ms. Karin Monaco and Ms. Nora Dei-Anang.

The development of this publication benefitted greatly from the valuable inputs, review and constructive comments received from Mr. Nigel Croft, Mr. Stephen Farquharson, Mr. Ulrich Harmes-Liedtke, Mr. Andy Henson, Mr. Pablo Jenkins, Ms. Miriam Loera, Mr. Alberto Medina, Mr. Martin Pillay and Ms. Lichia Yiu.

This publication was edited by Mr. Roger Frost and Ms. Lauren Cooke. Design and layout was developed by Ms. Radhika Nathwani.

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LIST OF ABBREVIATIONS

AB	Accreditation Body
AF	Adaptation Fund
AMR	Antimicrobial Resistance
ASME	American Society of Mechanical Engineers
BIPM	Bureau International des Poids et Mesures
BSDC	Business and Sustainable Development Commission
CA	Conformity Assessment
CABs	Conformity Assessment Bodies
CAC	Codex Alimentarius Commission
CAGI	Centre for Agriculture and Biosciences International
CEMAC	Economic and Monetary Community of Central African States
CEN	European Committee for Standardization
CFIA	Canadian Food Inspection Agency
CGPM	General Conference on Weights and Measures
CIMO	Commission for Instruments and Methods of Observation
CIPM	International Committee on Weights and Measurements
CO₂	Carbon Dioxide
CONUEE	National Commission for Energy Efficiency Mexico
COP	Conference of the Parties
CRM	Certified Reference Material
CSA	Canadian Standards Association
CWA	USA Clean Water Act
DCMAS	Developing Countries in Metrology, Accreditation and Standardization
EC	European Commission
ECOWAS	Economic Community of West African States
EE	Energy Efficiency
EEC	European Economic Community
EnMS	Energy Management Standards
EPA	Economic Partnership Agreement
EPA	Environmental Protection Agency
ETS	EU Emissions Trading System
EU	European Union
EWS	Efficient World Strategy
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FIDE	Electric Power Saving Trust Fund in Mexico
FIDSL	Food Industries Development Supporting Laboratory

FSSC	Food Safety Management System Scheme
GDF	Global Drug Facility
GDP	Gross Domestic Product
GDWQ	WHO Guidelines for Drinking Water Quality
GCF	Green Climate Fund
GEF	Global Environment Facility
GFSI	Global Food Safety Initiative
GHG	Greenhouse Gas
GMP	Good Manufacturing Practice
GCOS	Global Climate Observing System
GOS	Global Observing System
GRMS	Global Red Meat Standard
GSSI	Global Sustainable Seafood Initiative
Gt	Gigatons
GVCs	Global Value Chains
GW	Gigawatts
GWP	Global Water Partnership
HLPF	High-Level Political Forum on Sustainable Development
HLPW	High-Level Panel on Water
IAF	International Accreditation Forum
IBWM	International Bureau of Weights and Measures
ICH	International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFCC	International Federation of Clinical Chemistry and Laboratory Medicine
IFS	International Featured Standards
ILAC	International Laboratory Accreditation Cooperation
IMDRF	International Medical Devices Regulators Forum
INACAL	National Quality Institute of Peru
INetQI	International Network on Quality Infrastructure
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IPRs	Intellectual Property Rights
IRENA	International Renewable Energy Agency
ISEAL	International Social and Environmental Accreditation and Labelling Alliance

ISID	Inclusive and Sustainable Industrial Development
ISO	International Organization for Standardization
ISO/CASCO	ISO Committee on Conformity Assessment
ISO IWA	ISO International Workshop Agreement
ISPM	International Standards for Phytosanitary Measures
ISQua	International Society for Quality in Healthcare
ITC	International Trade Centre
ITP	Technological Institute of Peru
ITU	International Telecommunication Union
IVD	In-vitro diagnostic
IWRM	Integrated Water Resources Management
JCTLM	Joint Committee for Traceability in Laboratory Medicine
LCA	Life-Cycle Assessment
LDCF	Least Developed Countries Fund
LNSP	National Public Health Laboratory Côte d'Ivoire
LVDC	Low Voltage Direct Current
MBS	Malawi Bureau of Standards
MEPS	Minimum Energy Performance Standards
MFPEA	Myanmar Food Processors and Exporters Association
MITS	Myanmar Inspection and Testing Services Ltd.
MLA	Multilateral Recognition Agreement
MRA	Mutual Recognition Agreement
NAAHLS	National Aquatic Animal Health Laboratory System
NDC	Nationally Determined Contribution
NMI	National Metrology Institute
NSB	National Standards Body
NVWA	Netherlands Food and Consumer Product Safety Authority
OECD	Organization for Economic Cooperation and Development
OIML	International Organization of Legal Metrology
PHC	Primary Healthcare
PIQAC	Quality Infrastructure Programme for Central Africa
PGR	Plant Genetic Resources
POP	Persisting Organic Pollutant
PQ	Power Quality
PV	Photovoltaic
QA	Quality Assurance
QI	Quality Infrastructure
QP	Quality Policy
QMS	Quality Management System
RECP	Resource Efficiency and Cleaner Production

R&D	Research and Development
RM	Reference Material
RTA	Regional Trade Agreement
SAFA	FAO's Sustainability Assessment of Food and Agriculture Systems
SCCF	Special Climate Change Fund
SDGs	Sustainable Development Goals
SDWA	USA Safe Drinking Water Act
SEWA	Sharjah Electricity and Water Authority
SHP	Small Hydropower
SI	International System of Units
SME	Small and Medium-sized Enterprise
SOAC	West African Accreditation System
SPS	Sanitary and Phytosanitary
TBT	Technical Barriers to Trade
TFA	Trade Facilitation Agreement
TII	Department of Trade, Investment and Innovation (UNIDO)
TWh	Terawatt-hour
UAE	United Arab Emirates
UHC	Universal Health Coverage
UNCCD	United Nations Convention to Combat Desertification
UNECE	United Nations Economic Cooperation for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UN	United Nations
VNR	Voluntary National Review
VP	Validation Panel
VSS	Voluntary Sustainability Standards
WASH	Water, Sanitation and Hygiene
WBG	World Bank Group
WEF	World Economic Forum
WFD	EU Water Framework Directive
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WSP	Water Safety Plan
WWF	World Wildlife Fund

SPEED READ THE ESSENTIALS

Who can most benefit from this publication?

The publication is primarily aimed at policy makers, people who work in national quality infrastructure systems, and other QI stakeholders. It will also be useful for those responsible for developing national implementation plans for the UN's Sustainable Development Goals. More broadly, the publication will also benefit those in search of an introduction to QI and concrete examples of its application in different countries and areas of economic activity.

The publication should serve as an advocacy document aimed at:

- » Policy makers – showing them how QI can address new challenges
- » People involved in QI – describing the innovations needed to ensure QI is sustainable, fit-for-purpose and forward-looking

Why should you read this publication?

The text provides a holistic overview of the need for quality infrastructure to attain the objectives of the SDGs - organized by their three key dimensions of “prosperity, people and planet” – and to achieve sustainable development objectives in general.

It is useful for those who work in sustainable development to learn how QI can contribute to a detailed analysis of its application to sustainable development. The publication meets these needs while making clear the links between QI and sustainable development.

The publication is forward-looking and highlights the important need for QI to adapt to a new future, focusing on a circular economy that is inclusive, economical, ecological and sustainable.

It highlights the interplay and relationship between QI and technological change. The future will be characterized by rapid and disruptive technological change and QI must be able to integrate new technologies.

What specific benefits can this publication bring?

An understanding of QI means:

- » Improved ability to create and implement sustainable policies with measurable impacts. QI is an essential ingredient in all socio-economic and environmental policies. Its appropriate application has great potential to contribute to economic development, improve the livelihoods of people, and help safeguard the environment
- » Countries, especially developing countries and the least developed countries, will be able to make better use of their resources and more efficient decisions on which activities to invest in
- » A culture of quality will become mainstream and will be present in all aspects of life

What if I, my government or my organization is convinced by the arguments? What are the first steps to take? What can we reasonably expect to happen?

- » Establish a quality policy relevant to your needs, underpinned by the principles of ownership, inclusiveness, coherence, optimization and sustainability. During this process, a country's QI requirements will be identified through a needs assessment to ensure that a demand-driven QI is created
- » Encourage your country's participation in QI decision-making at the regional and international levels. This includes, for example, participating in the technical committees that develop standards. This is particularly important regarding standards related to technological advancement and the future. Examples are standards being developed for Industry 4.0 and new technologies such as artificial intelligence
- » Expect better policies that are built on the solid foundations of quality integrated with sustainability, as well as being more effective and aligned with best practice

EXECUTIVE SUMMARY

This publication provides insights – with examples – into how a quality infrastructure (QI) supports and strengthens the implementation of the United Nations' Sustainable Development Goals (SDGs). It describes how QIs better position developing economies to meet the SDGs by creating prosperity through inclusive economic development, enhancing 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. UNIDO promotes good practice, capacity building and training, and fosters global cooperation in the development of standards-setting, measurement and compliance along value chains. It works with partners from the public and private sectors, academia, national and international organizations engaged in standards development, and global metrology, standards and conformity assessment practice.

A national QI comprises institutions in charge of metrology, standardization, accreditation, conformity assessment and market surveillance, as well as the related policy, services and legal and regulatory frameworks. Establishing a QI can substantially assist a nation in pursuing a development path aligned with the SDGs, overcoming the challenges involved and benefitting from the considerable opportunities generated through achievement of the SDGs.

A QI contributes to improvements in three of the five dimensions addressed by the SDGs: prosperity, people, and planet. These dimensions strongly underline the interdependence of the various goals, targets and approaches, and the need to implement them in an integrated manner. Because a QI encourages the use of standards built on consensus, it can strengthen international cooperation and partnerships – thus it can be a force for peace.

The foundation of a strong QI consists of five building blocks:

METROLOGY

This provides reliable measurements as a basis for scientific research, technical development and production. Metrology is also needed to ensure that goods, services and processes comply with product quality, environmental, health and safety requirements, as well as meeting consumers' needs and expectations.

STANDARDIZATION

This distils and makes available international expertise and knowledge regarding usability, quality, safety, performance or any other characteristics required by users, buyers and producers. Standards contain technical specifications for products or product components (e.g. dimensions, sizes, formats, tolerances, performances and interfaces). They are also repositories of knowledge for product testing; for requirements for services, processes and systems; for guidance on how to conduct activities; for descriptions of best practices applied by experienced professionals in a given field, and for other specific information.

CONFORMITY ASSESSMENT

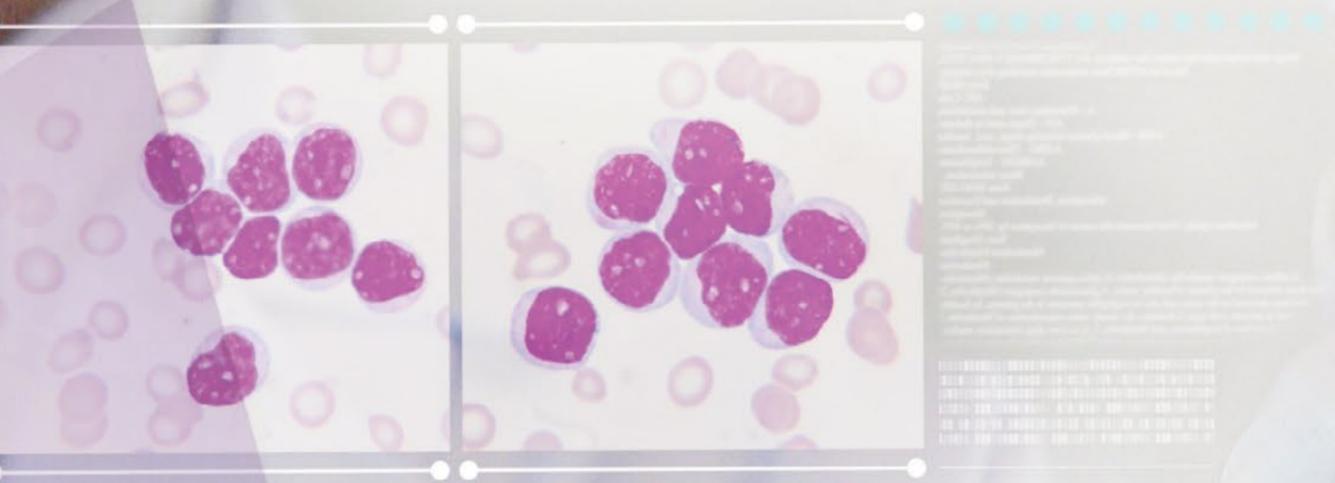
This provides scientific and technical evidence of whether or not products meet standards or other requirements; are fit and safe for humans, animals, and the environment; and whether or not processes are organized and managed in conformity with accepted good practices.

ACCREDITATION

This supports the correct functioning of conformity assessment systems. Accreditation bodies are responsible for providing a formal attestation of the integrity of conformity assessment bodies and their competence to perform specific conformity assessment activities.

MARKET SURVEILLANCE

This verifies whether products and services on the market comply with applicable regulations. Market surveillance authorities are usually under government responsibility.





PROSPERITY

Economic growth through trade

A QI supports domestic markets, making them more effective, facilitating their access to foreign markets as well as the diversification of their exports, and generally helps to promote economic development. For successful trade, manufacturers need to ensure that their products are of consistent quality, comply with relevant standards, and meet the appropriate consumer requirements and specifications in their intended market.

The UN's 2030 Agenda for Sustainable Development recognizes international trade as an engine for economic development and poverty reduction – a powerful force that promotes specialization, competition, economies of scale and innovation. “These powerful forces can, if properly harnessed, help make the world economy more sustainable and resilient to environmental risks while having positive effects on prosperity, jobs and equality”.¹

Harnessing this powerful force means that the trade engine for growth must be accompanied by policies and actions at national and international levels to ensure that they address: the social dimension, such as decent remuneration of workers, protection of health, safety and rights; as well as the environmental dimension, such as a more economically and environmentally efficient allocation of resources at the global level, and dissemination of environmentally friendly technologies and products.

A sound and efficient QI is indispensable to meeting the requirements of target markets and to harnessing the power of trade through measures that effectively address social and environmental aspects without creating 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

development. 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 promotes socio-economic development.

The insightful and cost-effective implementation of standards aligned with the SDGs by the private sector, and their promotion, support or enforcement by competent authorities, can also produce several important results:

- » Improve the ecological performance of materials and products
- » Support their energy efficiency
- » Drive and monitor the development of sustainable infrastructure and manufacturing

In this way, a QI advances environmentally sustainable growth by building institutional capacities for the creation of green industries that apply cleaner technologies for production and support sustainable product life cycles.

Digitalization and artificial intelligence are shaping what is becoming known as the Fourth Industrial Revolution (4IR), or Industry 4.0, which poses new challenges for measuring, testing and certifying new products. The associated new technologies can help improve quality in various ways. For example, companies can monitor processes and collect data in real time and apply analytics to predict quality issues and maintenance needs. Digital tools also enable people to do their jobs faster, better and at reduced cost.

Consequently, QI is in need of a paradigmatic change to evolve in step with the 4IR. This change requires not only improved technological capabilities, but also a change in the values and mindset of QI institutions and organizations. In this context, all five building blocks of QI will play a role in the dissemination and adoption of new standards, new devices and new approaches for minimizing risks, setting clear and common requirements and ensuring sustainability.

¹ World Trade Organization and UNEP, “Making trade work for the environment, prosperity and resilience”, 2018.

PEOPLE

Food security and sustainable agriculture: The future of agriculture presents daunting and diversified challenges. For countries with a high population density and limited agricultural activity, a key objective is not to jettison food security and environmental sustainability in efforts to achieve high crop productivity. For the least developed countries (LDCs) the overarching goal is to eradicate hunger and to secure adequate nutrition for all people.

QI institutions and the services they provide ensure that food is fit and safe for consumption. They urgently need to evolve to support sustainable agriculture and food production, which in turn allows people to live healthy lives and improve their social and economic well-being. QI is also indispensable in supporting trade in food and agricultural products, which is an important component of export for many developing countries.

Good health and well-being: QI plays a pivotal role throughout the health sector which depends on inputs from medical devices, processes or activities. In fact, quality healthcare is underpinned by the accurate dosage of medicines and of physical and chemical processes or activities, as well as biological measurements used to diagnose health conditions and ensure therapies are delivered safely and effectively. 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.

Gender equality: QI development has the potential to have positive impacts on gender equality and in the economic empowerment of women. In particular, the development of gender-sensitive standards can aid the drive for gender equality as they ensure that gender considerations are sufficiently taken into account.

Affordable and clean energy: QI, if accompanied by appropriate policies, provides valuable and critical support for governments and organizations as they seek to enhance energy efficiency, economic performance and the transition to clean energy, whilst preventing unsafe, unhealthy or environmentally harmful products from entering the marketplace.

Water and sanitation: QI provides the technical means to ensure that water can reach more people and is demonstrably safe for consumption. In addition, it allows for pollution control and the promotion of water efficiency. Metrological services support the development of reliable and internationally comparable metrics for tracking the level of reserves, the rate of extraction and the quality of national water sources, as well as the calibration of water meters that guarantee conservation and sustainable use and consumption.





PLANET

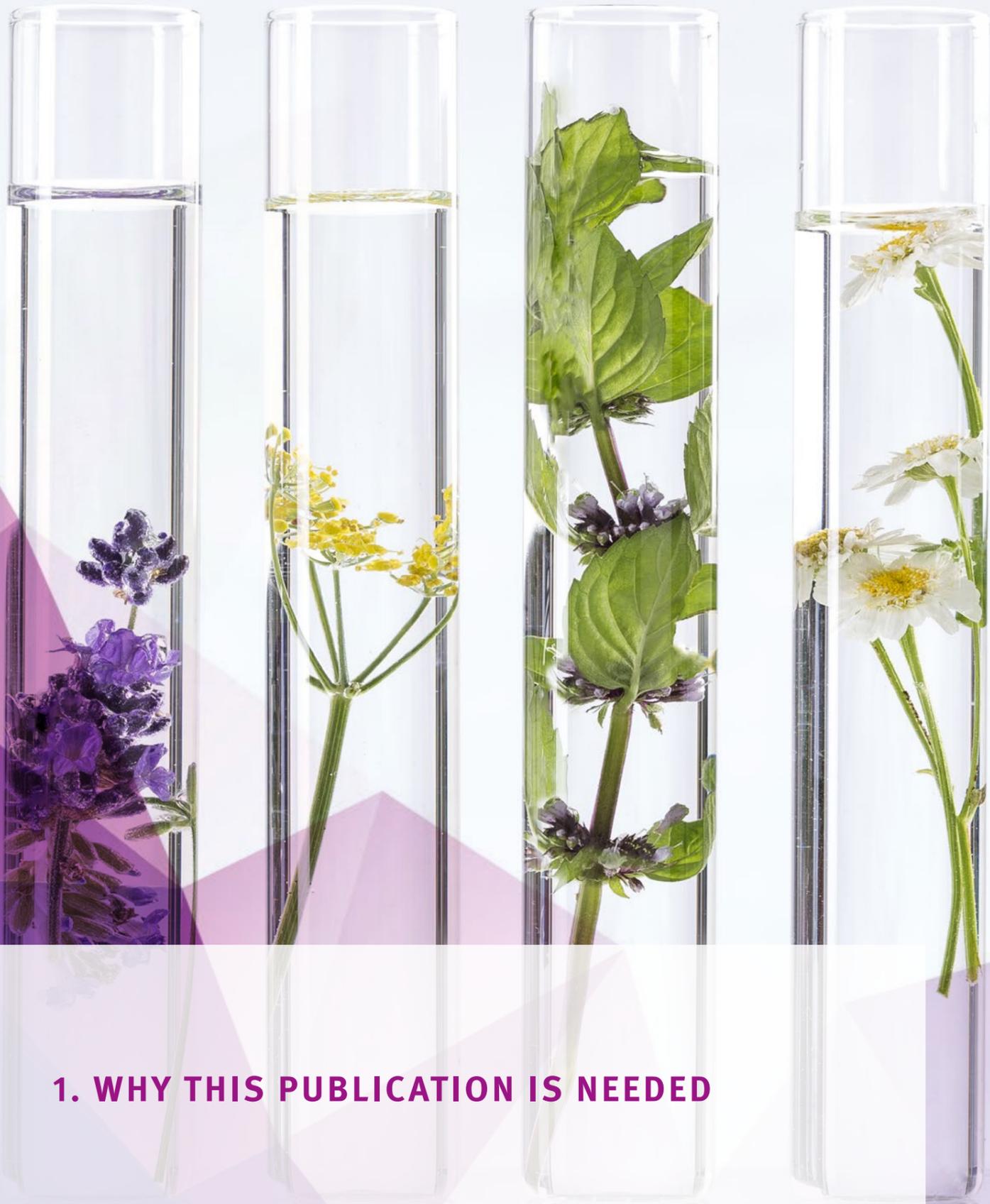
Protecting life below water and on land: Protecting and nurturing our environment is indispensable for people's well-being and for human survival. The impact of human activity on the planet has reached dangerous levels, threatening the sustainability and management of natural resources and the protection 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 to economic development is adopted, in which environmental sustainability is a key priority. QI institutions and services provide an essential contribution to the implementation of policies and actions aiming to achieve the sustainable use of marine resources (life below water) and the protection of ecosystems (life on land) – in terms of measurement capabilities, dissemination of good practices, support to management, and the monitoring, reporting and verification of compliance.

Responsible consumption and production: Today's principal economic model, consolidated and expanded in the second half of the 20th century, is centred on the provision of an ever-growing flow of goods and services. These then need to be rapidly consumed and replaced by new products and services, in an upward, accelerating spiral. This model is a primary cause of the key challenges that the world is facing today.

Consumption and production patterns need to change radically, decoupling economic growth from both the consumption of resources and environmental impact. Such decoupling could be achieved by reducing the material and energy intensity of economic activities, along with the emissions and waste related to them. By promoting a shift of consumption towards goods and services with lower energy and material footprints, quality of life is not compromised.

QI institutions and services are indispensable in supporting the transition towards sustainable consumption and production patterns. They can provide the accurate information about the materials, energy, water and land used - as well as emissions and waste. These parameters are needed to develop and apply sustainability policies, and to encourage virtuous, eco-friendly behaviour by the key concerned parties.



1. WHY THIS PUBLICATION IS NEEDED

In September 2015, 193 member states of the United Nations adopted a historic resolution committing themselves to the 2030 Agenda for Sustainable Development.² It contains 17 Sustainable Development Goals (SDGs) and 169 targets that seek to build on the Millennium Development Goals (MDGs), which expired in 2015. The SDGs are ambitious, universal, transformational and applicable in both developed, developing and the least developed countries. Furthermore, they are aimed at balancing economic development, 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 UN itself. The transition from the MDGs to the SDGs was 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 was then termed "social progress and better standards of life" and today is generally described as human development and human well-being.³ The 2030 Agenda for the SDGs sets forth an integrated plan of action structured in four main parts, as shown in the figure below:

AGENDA STRUCTURE



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

The implementation of the 2030 Agenda's vision of sustainable development requires an integrated

² Transforming Our World: "The 2030 Agenda for Sustainable Development" (UN General Assembly resolution 70/1, 25 September 2015) or in short, the 2030 Agenda.

³The 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.

approach. The SDGs⁴ are interdependent and call for collective action at all levels. They aim to address the challenges of our time, with the overarching imperative of leaving no one behind, and addressing inequalities and discrimination as a defining feature. For many developing countries, the 2030 Agenda was timely 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 have a fundamental role to play in supporting this transformation through the metrology, standardization, accreditation, testing, inspection and certification services they provide and enable.

Concurrently, QI institutions and services are under growing pressure. We are living in an era of disruption in which technological advancements, environmental concerns, demographic growth and trade tensions are swiftly reshaping the global economy. In this context, transformational change can be facilitated by the valuable contribution of QIs to enhance the ability of national and regional institutions to make informed policy decisions, ensure best business practices and promote capacity building to meet new challenges.

Moreover, 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 required measurement techniques and conformity assessment methodologies, is where the contributions of national and regional QI institutions make a difference.

Establishing a quality policy (QP), and the associated QI, adapted to the needs of developing nations, will substantially assist them in driving the required change; At the same time, it will position their economies to seize the many opportunities available through the holistic implementation of the SDGs. However, this strategic direction will require major efforts to ensure the alignment of QI institutions and services with the SDGs: in particular, in defining priorities and creating or completing the new sets of standards and CA services needed to achieve them.

The information and examples provided on the following pages are intended to enable an understanding of the role of QI by providing insight and examples of how a QI supports and underpins the implementation of the SDGs.

⁴The 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".



2. OVERVIEW OF QUALITY INFRASTRUCTURE

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
- » market surveillance.

Source: INetQI

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

Metrology

Common units of measurement, accurate and reliable measurement instruments and techniques are all fundamental components of science and technology and indispensable for a broad variety of human activities.

Offering a product or service that is consistently fit-for-purpose, thereby protecting the health and safety of the environment and the consumer, makes accurate and consistent measurements and measuring equipment indispensable. Firms cannot satisfactorily implement process controls to manufacture a product or deliver a service that continually meets the required characteristics if instruments 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.

This is the domain of metrology – the science of measurement. It covers subject areas ranging from the definition of units of measure, to the realization of such units in practice and to ensuring metrological traceability down to the workplace.

A metrology system comprises scientific, industrial, and legal 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 (BIPM) – scientific and industrial metrology) and the International Organization of Legal Metrology (OIML) – legal metrology). More information on both of these organizations is contained in Annex A.

Standardization

Products and services should meet the expectations of those who use them, should perform as intended, and 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, and best practices. Products and services that can be shown to 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’s Agreement on Technical Barriers to Trade (WTO/TBT) defines a *standard* as a voluntary document to which compliance is not mandatory, as opposed to a *technical regulation*, to 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.

National 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 use in the domestic market. In order to facilitate global trade, national standards and technical regulations should, wherever possible, be based on international standards, so the NSB also typically represents a country’s interests at regional and international organizations that develop such consensus-based standards.

OVER 1,000 STANDARDS PROVIDERS

There are probably more than 1,000 standards-developing organizations (SDOs) around the world. One of the global leading providers of standards, codes and other technical publications, IHS Markit, offers access to over 1.2 million records from over 500 SDOs and publishers.

The GB China National Standards Service Center provides access to about 200,000 Chinese national standards and industry standards. At the end of 2018 ISO, the largest international standards developer had a portfolio of 22,513 international standards, the IEC 10,771 and the ITU over 4,000 (named ITU-T recommendations).

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.

Conformity assessment

Conformity assessment refers to the processes and procedures that are used to determine that a product

⁵ Para 2, Annex 1, “Agreement on Technical Barriers to Trade”, World Trade Organization.

or service, process, management system, or personnel meet specified requirements. Conformity assessment services are performed by organizations – conformity assessment bodies (CABs) – that specialize in testing, inspection and certification.

- » **Testing:** Testing a product, service or process against a specific set of criteria, such as those for performance or safety, is the most common form of conformity assessment. Testing also provides support for other types of conformity assessment such as inspection and product 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 in the private and public sectors for examining a wide range of domestically produced or imported products, materials, installations, plants, processes, work procedures and services
- » **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 conformity assessment services may offer these on a commercial basis or they may be operated or mandated by the government. The conformity assessment 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.

Accreditation

Conformity assessment service providers (such as CABs) need to provide confidence that they operate impartially and possess the competence to determine whether or not the various requirements are being met. These requirements can be specified by laws and regulations, or be set by standards developed by industry or other stakeholders.

National and regional accreditation bodies (ABs) can provide such confidence by assessing CABs using criteria contained in international standards, and accredit those CABs that meet the criteria. Further recognition at the regional or global level can be achieved if the national AB is subjected to an evaluation of its operations by its peers (other ABs), after which it can be invited to join international and regional cooperation arrangements administered by the International Accreditation Forum (IAF) and the International Laboratory Accreditation Cooperation (ILAC). More information on these two organizations is contained in Annex A.

Market surveillance

Market surveillance refers to the activities (usually conducted by market surveillance authorities under government responsibility) to verify whether products

and services on the national market comply with applicable regulations. The purpose of these regulations is usually to ensure that products and services do not endanger health, safety, or the environment, and to strengthen trust between businesses and their clients.

Market surveillance can also refer to activities, which a manufacturer undertakes to collect and review experience gained from the use of their products in the marketplace. This includes the identification of issues that may need corrective or preventive action.

Challenges to developing a QI

The accelerated and widespread expansion of digital technologies across business and society has resulted in the emergence of the Fourth Industrial Revolution, also known as Industry 4.0.⁶ The new wave of industrial applications of the Internet of Things (IoT), artificial intelligence (AI), 3D printing and blockchain requires substantial changes to all five building blocks of QI.

The development and proper operation of a QI needs considerable financial and human resources and it will typically be several years before it is mature enough to function properly and achieve 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 they are shown to be accurate and repeatable. If local calibration and testing laboratories, auditors and certifiers are not recognized and accepted by clients in foreign markets, exporters often have to arrange for repeat conformity assessment procedures in every foreign market they serve. This is costly and can easily render them uncompetitive. This is true both for manufactured goods and agricultural products.

If a publicly funded national QI is not available or if it does not deliver acceptable results, local businesses need to procure such services elsewhere to satisfy the needs of foreign customers. The lack of such services can effectively prevent these businesses from participating in international markets and obtaining the associated benefits.

Small and medium-sized enterprises (SMEs) and other exporters from developing countries often find themselves in such a situation. Non-compliance 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 national QI system. Therefore, efforts should be concentrated on implementing and maintaining a single national system. It is also important to realize that a QI is an interdependent system where, if 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

⁶Klaus Schwab, "The Fourth Industrial Revolution: What It Means and How to Respond," World Economic Forum, accessed October 7, 2019. Available at: <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>

and consumers related to quality and can also be used to satisfy other regulatory needs. Regulators can incorporate standards that exist or are developed by the NSB to support their regulations, together with the use of accredited conformity assessment services as a means of enforcing technical regulations within their respective fields.

It is important to note that QI capacity does not replace the enforcement oversight responsibilities of regulators. They 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.

QI in support of the UN's SDGs

Establishing and operating a QI suited to the needs of a country is a great help in pursuing the SDGs.

A QI, through its institutions and services, provides technical and operational foundations indispensable to the functioning of modern societies. QIs support policy objectives in areas including industrial development, trade competitiveness in global markets, efficient use of natural and human resources, food safety, health, environmental protection, as well as mitigation of and adaptation to climate change.

All component parts of the QI act synergistically with each other and provide valuable tools for defining, developing and verifying requirements for products and services, helping to ensure and demonstrate that products and services actually meet specified requirements.

The QI institutions and their services can provide policymakers, businesses and other stakeholders with the technical knowledge and capacity to strengthen the implementation, measurement and monitoring of many of the objectives and targets contained in the SDGs, and support actions to achieve them.

INetQI and best practices

Responding to the challenges of globalization, trade and sustainable development, 12 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. They cooperate as part of the International Network on Quality Infrastructure (INetQI) whose members are:

- » International Bureau of Weights and Measures (BIPM)
- » International Organization of Legal Metrology (OIML)
- » International Electrotechnical Commission (IEC)
- » International Organization for Standardization (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 Developing Countries in Metrology, Accreditation and Standardization, DCMAS) has collaborated in providing technical quality infrastructure training programmes (in Poland and Mozambique, in 2014 and 2015 respectively) and in the development of diverse publications and guidance documents.

In the framework of the network, a set of three documents have been developed under the leadership of UNIDO to support developing countries in the formulation of their quality policies: a set of guiding principles; a technical guide, and a practical "step-by-step" tool. The INetQI agreed in 2017 on an updated definition of QI. The new definition expands the scope of action to promote global acceptance of a QI and is expected to create additional benefits for stakeholders including its use as a foundation for sustainable development.

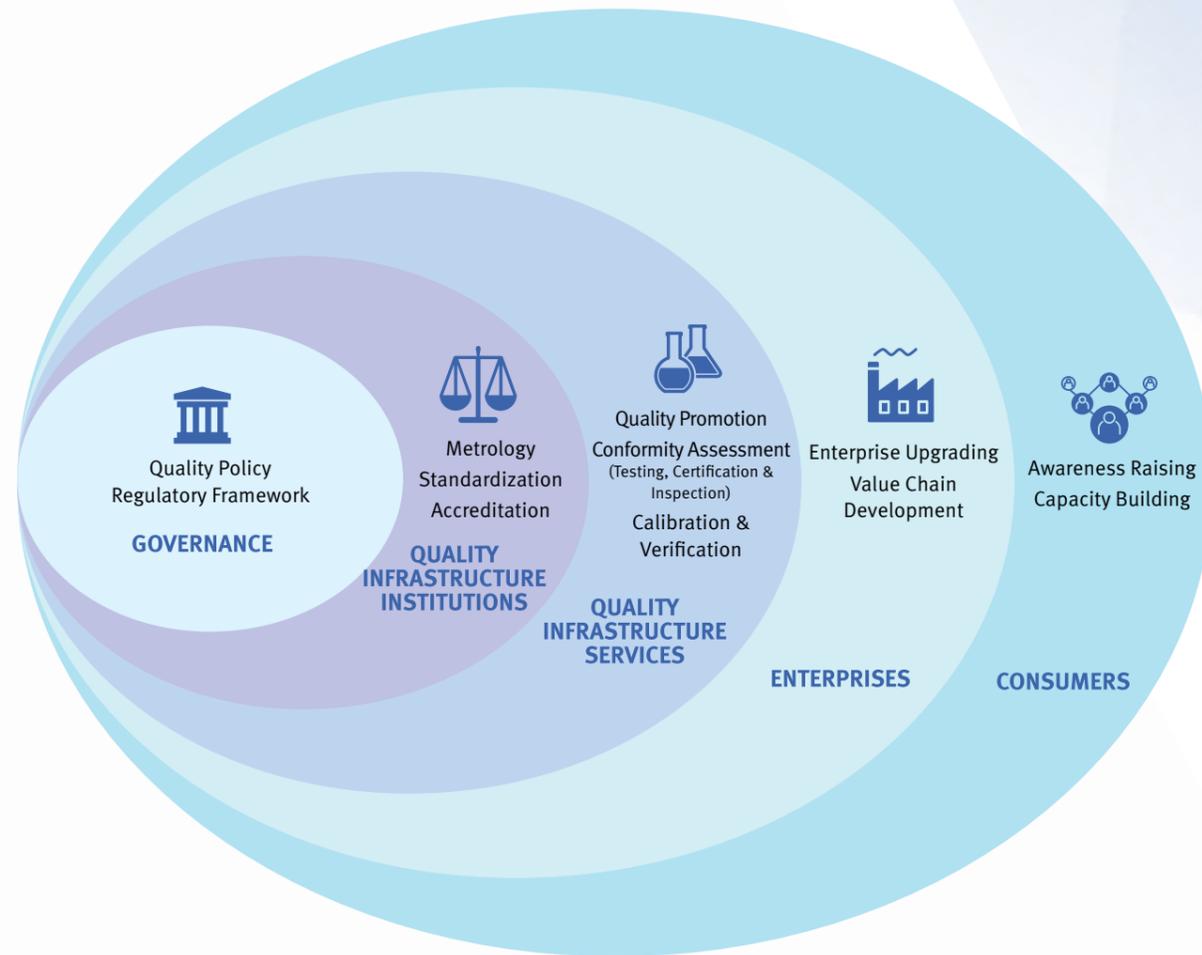
UNIDO's QI role

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).

These programmes provide developing countries, and economies in transition, with 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 policymakers, businesses, and other stakeholders with core knowledge about best practice and the tools needed for its implementation.

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

The Quality Infrastructure System:



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3. OVERVIEW OF THE SDGS

The UN's 17 interconnected and complementary Sustainable Development Goals (SDGs) represent a global call for action to protect the planet, ensure dignified lives for all people, and achieve inclusive economic development, 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.

Governments are responsible for setting national targets, adopting suitable policies and ensuring that the necessary actions are taken to meet them. Societal actors, such as businesses and consumers, are also fundamental contributors to attaining the goals.

The SDGs present an opportunity for companies to align their strategies and business models with global sustainable development needs. Individuals are encouraged to contribute to the creation of a better world, now and for future generations, by active engagement and actions such as participating in the development and promotion of policies and behaviours supporting the SDGs and by practicing sustainable consumption.

The SDGs, directly supported by the development of quality policy and the associated quality infrastructure, address three dimensions: prosperity, people, and planet.

BUILDING PROSPERITY

Two SDGs relate to economic development: *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.* These goals direct attention towards industry; innovation and infrastructure; responsible production and consumption; decent working conditions, and economic growth that is no longer accompanied by degradation of the environment.

MEETING THE NEEDS OF PEOPLE

Five SDGs relate to societal issues: *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; SDG 5 – Achieve gender equality and empower all women and girls.* They call for eradicating poverty, improving health and the empowerment of people. These issues, and others identified in the goals, are crucial elements of well-functioning societies.

PROTECTING THE PLANET

Protecting the biosphere is an essential precondition for everything else, including economic development.

There are four SDGs contributing to this dimension: *SDG 13 – Take urgent action to combat climate change and its impact; 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 goals are not achieved, success in reaching the other SDGs is almost impossible. The activities related to the production, transportation, and trade and consumption of goods and services have a tremendous impact on the biosphere. Negative impacts which these SDGs are intended to mitigate 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 an essential driver for prosperity. Up to now, however, economic activity has accounted for the unsustainable exploitation of finite natural resources and degradation of the environment.

To preserve natural resources and a healthy biosphere for future generations, it is imperative that businesses and their clients are aware of the negative consequences of a short-term focus. They must 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, and calls for radical change and innovative solutions.

While some may perceive environmental and societal demands as constraints, the orientation of policies and business strategies towards the SDGs offers immense opportunities to those who are able to embrace and address these challenges. The 2017 report by the Business and Sustainable Development Commission (BSDC) elaborates on the ways in which corporate practices and markets need to change. The report also highlights that such a transformation would unlock USD 12 trillion of market opportunities for businesses and could create at least 380 million new jobs by 2030.

Since 2015, governments have begun to incorporate the SDGs and targets into the mainstream of their national plans and many now report on their progress in this regard. National plans detail programmes, projects, and related tasks. They specify the ministries and other stakeholders involved and detail the modalities of putting them into practice. 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. In 2016 and 2017, more than 60 countries reported through voluntary national reviews⁷ (VNRs) on their progress in implementation and the specific challenges they encountered.

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

- » Decision makers in the public and private sectors need to take a holistic view during the design and implementation of a national sustainable development strategy. This includes recognizing 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, short-term economic imperatives and financial needs versus the longer-term SDG aspirations and associated gains
- » However, it is not enough to recognize that SDG-related issues are interconnected, and require strong institutions with economic, social and environmental mandates. Public institutions with mandates that make them stakeholders must coordinate the implementation of related activities in close cooperation with private sector organizations. For example, environmental considerations should be 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 overcome the intended benefits of sustainable 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
- » In order to meet the intent of the SDGs within their deadlines, there is a critical need for cooperation and partnerships – both within and between economic sectors, across borders, at government-to-government level, and among non-state actors and the private sector
- » It is important that countries align current and planned national capabilities and resources with their national SDG priorities to ensure effective implementation. Among the requisite capabilities and resources is the development and maintenance of a national QP and associated QI





4. BUILDING PROSPERITY

Prosperity in the context of the SDGs seeks to ensure that all human beings can enjoy prosperous and fulfilling lives, and that economic, social and technological progress occurs in harmony with nature.⁸



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

4.1 Industry, innovation and infrastructure

SDG 9 promotes socially inclusive and environmentally sustainable economic development by enhancing infrastructure, industry and innovation. It calls for more opportunities for all women and men, as well as across social groups, by building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation.

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 efficient methodologies
- » Create green industries spurred by technology facilitation, innovation and partnership building

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 is recognized as a key driver for economic development, mainly in the past for developed countries, and today in developing ones.

The so-called “Kaldor’s laws”⁹, which have an empirical basis and are an important reference for developing economics, indicate that:

- » GDP growth is positively correlated to the growth of the manufacturing sector
- The manufacturing sector enjoys increasing returns of scale - that is productivity increase is positively correlated to the manufacturing sector’s growth

⁸Scaling Up Nutrition (2015), “The 2030 Agenda: For people, Planet and prosperity”. Available from: <https://scalingupnutrition.org/news/the-2030-agenda-for-people-planet-and-prosperity/>

⁹Laws relating to the causation of economic growth, named after Nicolas Kaldor, prominent Cambridge economist in the post-war period – Available at: <http://www.hetwebsite.net/het/profiles/kaldor.htm>

- » Productivity of non-manufacturing sectors is also positively related to the growth of manufacturing (spillover effect)

Manufacturing can therefore be considered an “engine for growth” - which historically has followed some general trajectories – even if specific sectors and development steps depend on each country’s characteristics, conditions and availability of resources.

INDUSTRIALIZATION AS A DRIVER FOR PROSPERITY

In his foreword to the UNIDO publication Structural Change for Inclusive and Sustainable Industrial Development (2017), the UNIDO Director General, LI Yong, states: “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: “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”.

Innovation is another essential factor for the development of industry and is particularly important in today’s knowledge-based economies. The Organization for Economic Cooperation and Development (OECD) defines innovation¹⁰ 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 one of the essential drivers of a successful business and a key contributor to a nation’s productivity, and economic and social development. It applies to:

- » Product improvements – higher quality, increased automation, new products
- » Process improvement – achieved through automation, new organizational models and methods
- » Service improvement – better customer service and after-sales maintenance, new ways of managing information and transactions
- » Marketing improvements – how to reach and communicate with existing and potential customers, approaches to reward customers, and mechanisms to increase the transformation of leads into sales

Encouraging innovation is an important issue for both forward-thinking companies and governments. Standardization and standards are necessary to move innovation forward. In 2012, the International Telecommunication Union (ITU) established a programme on International Mobile Telecommunications (IMT) for 2020 and beyond, a framework for 5G and research and development (R&D) worldwide. ITU’s

¹⁰ Oslo Manual: “Guidelines for Collecting and Interpreting Innovation Data”, OECD, 2005.

Radiocommunication Sector (ITU-R) is coordinating the international standardization and identification of spectrum for 5G mobile development. ITU's Standardization Sector (ITU-T) is playing a similar convening role for the technologies and architectures of non-radio elements of 5G systems.

ISO STANDARDS FOR INNOVATION

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 56002, published in 2019, provides guidance for developing an innovation management system. Also published in 2019, 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.

ISID, challenges and transformation

The establishment and the evolution of a sound industrial structure is not an easy task, in particular for developing countries. They have to develop the physical components of infrastructure (energy, transportation, water supply, information, communication, among others) along with the institutions and services of QI, which are indispensable to industrial development. Moreover, they have to develop these *now*, compared to the decades which developed countries disposed of.

Today's challenges are both broad and complex. Advances in digital technology are driving the Fourth Industrial Revolution (4IR). These include artificial intelligence (AI), the Internet of Things (IoT), machine learning, robotics, additive manufacturing (3D printing), distributed ledger technology (such as blockchains), and quantum computing. The impact of these advances is leveraged by integration with nanotechnology and cognitive, social and humanitarian sciences (convergent technologies).

These leading technologies are innovative, fast-growing, deeply interconnected and interdependent. The convergence of previously fragmented and disconnected scientific disciplines and technologies is self-enforcing, advancing science, technology, and innovation, entrepreneurship and structural transformation. They have the potential to address pressing global challenges – such as ageing populations in developed countries, rapid population growth in Africa and the least developed countries, food security, environmental degradation and climate change – and to ensure access to energy and education.

The rising affordability of these new technologies promises to deliver multiple economic, environmental and social benefits and to realize the 2030 Agenda for Sustainable Development and its related SDGs

and targets. New possibilities for data collection, management and analytics can enable more agile, efficient and evidence-based decision-making, and can contribute to the better measuring of progress of the SDGs.

These new technologies are already helping to reshape business models and industrial processes. Companies can monitor processes and collect data in real time and apply analytics to predict quality issues and maintenance needs. Therefore, it becomes essential that QIs move forward at the same pace as industry and business are adapting to the digital era.

The rapid spread of new technologies and their convergence are calling for new standards for measurement values, reliable data, complex algorithms, statistical procedures, communication and security architectures. For example, digital technologies have an impact on metrology institutions' areas of activity and roles. Thus, new standards are needed for:

- » Innovative measurement techniques on high-frequency communications
- » Simulations and virtual measurements
- » Additive manufacturing
- » The use of new devices, such as smart sensors
- » New connected networks with big data, cloud computing, distributed measuring instruments
- » New roles for the integration of innovative technologies taking into account legal conformity requirements and supporting market surveillance¹¹

Thus, a far-reaching improvement of QI systems is now critical to enable them to cope with the ongoing transformation and avoid becoming hurdles to innovation.¹²

QI services and institutions also present countries with challenges and opportunities for increasing their participation in global value chains (GVCs). Since the 1970s, the rapid growth of global trade has been primarily characterized by the export of intermediate goods exchanged through these chains. In fact, GVCs account for at least two-thirds of today's global trade.¹³ Being able to participate in and take advantage of GVCs is therefore imperative.

At the same time, the speed of the adoption of digital technologies makes it harder for developing countries to participate in GVCs. As innovation is outpacing institutional responses, it is vital to re-orient and re-structure QIs to match the prevailing dynamism.

Industrial safety and security provide examples. They apply to the management of all conditions,

¹¹Eichstädt, Sascha. "Metrology for the digitalization of economy and society", 2017.

¹²Nilsson, Merih Malmqvist. Background paper for break-out 1: "Future Trends in Conformity Assessment and CASCO Standards in Industrialization 4.0", 2019.

¹³"Inclusive and Sustainable Growth: The SDG Value Chains Nexus", ICTSD, 2016.

operations and events at an industrial site with the aim of reducing, controlling and eliminating hazards and protecting humans, production assets, and the environment. They are therefore crucial to sustainable industrial development, including such aspects as industrial product and process safety; material safety; occupational health and safety; workplace safety; technical equipment safety; building and structural safety; environmental safety, and cyber security.

The new technologies of the 4IR are creating new opportunities and challenges for securing industrial safety. They will make some work environments safer, and may render current industrial safety regulations obsolete. New sources of safety risks such as physical risks and hazards appear as a result of new human-machine interactions. In addition, security risks associated with new vulnerabilities of processes and data may result in cyber-attacks with data loss and physical damage. The use of harmonized new standards and business protocols for interoperability, new risk management systems and digital skills training can greatly contribute to improving industrial safety and cybersecurity.

The accelerated pace of change has also brought concerns over the distribution of products. Consequently, "Development is increasingly not only about raising income but the form growth takes also matters. Issues of inclusion (with as many as possible benefiting from the proceeds of growth) and sustainability (with growth minimizing the environmental impact) have become crucial".¹⁴

Increasing environmental and social concerns are indeed critical aspects of today's path to development. Industrialization and infrastructure development in the 21st century must address issues within a radically different context than previous eras. Compared to the beginning of the 20th century, today's context has undergone major upheavals:

- » The world population has increased more than three times, from less than two billion people to over seven billion
- » The biosphere has been 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 was not an issue for decades and not considered in previous growth models, is now a phenomenal global challenge
- » Humanity is outgrowing the boundaries of our planet¹⁵ and this has enormous implications on how industrialization and infrastructure development should now be pursued

¹⁴ UNIDO (2017), "Structural Change for Inclusive and Sustainable Industrial Development".

¹⁵ For a definition of planet boundaries see: Johan Rockström, Will Steffen et al., Planetary Boundaries: Exploring the Safe Operating Space for Humanity, Ecology and Society, 2009.

Therefore, there are some fundamental issues that need to be considered in the pursuit of ISID and these are outlined in the following paragraphs.

Industrial and infrastructure development have 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 cheaply remedied.

The damage caused during the indiscriminate extraction of natural resources is often irreversible, for example, deforestation dramatically increases net carbon dioxide emissions, unsustainable agricultural techniques cause soil degradation, contamination of surface water and inefficient irrigation techniques and inappropriate 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 for human health and environmental degradation.

ECUADOR'S ANTI-POLLUTION DRIVE

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

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 need to be carefully considered by policy makers and industry leaders engaged in the development of sustainable industry and infrastructure.

The role and results of QI

The disciplines, organizations, practices and policies that collectively constitute what today is known as QI have been historically fundamental in enabling and supporting the development of industry and, in particular, manufacturing. Metrology, standardization and the assessment of conformity to requirements and specifications needed to evolve alongside the

Industrial Revolution that originated in Europe in the 19th century.

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.

STANDARDIZATION TO PREVENT TRAGEDY

The worst maritime disaster in the history of the United States was the sinking of Mississippi River's side-wheel steamboat Sultana 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 was not 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 the performance and safety of boilers and pressure vessels.

Quality products and their production systems rely on the availability of materials, components, interfaces and assembly processes relying on accurate measurements of a wide range of parameters. This requires national or regional QI organizations and services for conformity assessment including metrology, standardization, testing, certification and accreditation.

On the one hand, these organizations should ensure that components and finished products meet the regulatory requirements related to safety, health and environment. The results are more opportunities for participation in GVCs on the national and the regional level. On the other hand, QI organizations and services are critical for contributing feedback for national policy decisions regarding the establishment of regulatory frameworks for adopting new digital technologies and fostering innovation.

For this to happen, QI has to evolve along with the 4IR. It is essential that all five building bricks of QI are continuously reviewed and updated. For example, by encouraging a broader integration of researchers and innovators well-acquainted with the most recent trends in technological developments, standardization bodies can establish standards and good practice for conformity assessment that adequately meet the rapidly changing industrial needs.¹⁶

Similarly, the challenges that arise from the certification of intangible or constantly changing products, as is the case with machine learning and

¹⁶ Nilsson, Merih Malmqvist. Background paper for break-out 1: "Future Trends in Conformity Assessment and CASCO Standards in Industrialization 4.0", 2019.

AI applications, will require not only the use of new technologies and techniques, but also completely new thinking. To evolve in step with the ongoing industrial revolution, QIs require a change beyond the purely technical realm. They need to rethink and redefine basic concepts such as "product", "measurement units" and "method validation".

The absence of standardization and the lack of appropriate testing and inspection capabilities could hamper the ability of governments to develop, design and enforce regulations. The accelerated technological change risks leaving policymakers unprepared, for instance, to prevent a disproportionate concentration of technology benefits among a few actors and sectors.¹⁷ Paradoxically, technology companies and innovators perceive the lack of regulation and standardization as highly detrimental to their daily work.¹⁸

The critical function that national and regional QIs have in enabling and supporting economic development through advancing industrialization, promoting greater participation in the GVCs, supporting regulation and fostering innovation 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 the time pressure on developing countries.

The path forward

QI institutions and services have a fundamental role in industry and infrastructure. Under the guidance of a quality policy (QP), QI institutions need to catch up with the 4IR pace of development to support the development of sustainable industry and infrastructure better. Some specific areas where they have a role to play are:

- » Developing new standards associated to 4IR technologies and their harmonization to ensure interoperability, improve safety and security regulations and risk management, and facilitate their adoption by stakeholders
- » Disseminating and facilitating the adoption of innovative standards to improve the value of products, processes, organization, and marketing, in order to ensure long-term sustainability and competitiveness
- » Developing metrology, standards and conformity assessment procedures to assess and improve the ecological performance of materials and products and support the energy efficiency of products and systems, including the:

¹⁷ Mayer, Jörg. "Digitalization and Industrialization: Friends or Foes?" UNCTAD, 2018.

¹⁸ Eichstädt, Sascha. "Metrology for the digitalization of economy and society", 2017.



- » Environmental footprint of materials and products - based on life cycle assessment and other tools - and the definition of indicators and standardized rules for different categories of materials and products
- » 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 life cycle
- » Energy efficiency of buildings, industrial plants, vehicles, electrical appliances, etc.
- » Metrology, standards, accreditation, and CA procedures for testing, inspection and certification to embed sustainability requirements within projects (including infrastructure projects)
- » Metrology, standards, accreditation, 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 public policies, including a quality policy that promotes and supports aspects such as:

- » Embedding core sustainability criteria into future plans for economic development. This should specifically include the building of new, or the extension of existing, infrastructure, urban planning, and industrial development
- » Consistently using public procurement to promote and support technologies, solutions and good practices for sustainable industry and infrastructure. For example, the international standard ISO 20400:2017 provides guidance on sustainable procurement
- » Embedding well-defined sustainability criteria, indicators and targets in the design and implementation of public-private sector partnerships
- » Designing and applying social policies that aim to protect workers, sustain the poor and mitigate inequalities
- » Seeking financial support for sustainable infrastructure and similar projects from multilateral development banks, such as the World Bank, and other financial institutions that are increasingly active in this area

4.2 Decent work and economic growth



SDG 8 calls for structural transformation and economic growth by increasing the capacity of local industries for value addition, economic diversification, and export promotion, as well as for 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 of 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.

Economic growth through trade

The 2030 Agenda for Sustainable Development is not alone in recognizing international trade as an engine for economic development and poverty reduction. According to research by the World Trade Organization and the World Bank,¹⁹ “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. This 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, 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 have significantly depleted natural resources, increased pollution and encouraged operations causing environmental and social harm.

Industries, utilities and other organizations supplying goods and services, together with government as a procurement agency, need access to technologies that reduce water consumption, energy inputs, CO₂ emissions, air and soil pollution, and better manage solid waste and wastewater. Trade can be used as a vehicle to reduce the negative consequences of increased economic activity by making such technologies more easily available.

The WTO and the World Bank caution that “trade is not an end in itself.”²⁰

To achieve the intended outcomes related to the SDGs, including SDG 8, the value of increased trade needs to

¹⁹ World Bank Group and World Trade Organization, “The Role of Trade in Ending Poverty”. World Trade Organization: Geneva, 2015.

²⁰Ibid.

be measured by “the extent to which it delivers better livelihoods, through higher incomes, greater choice, and a more sustainable future”.

The same report underlines that sustained efforts will be required to increase economic integration and achieve 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.

In other words, this means that the trade engine for growth must be accompanied by policies and actions, at national and international level, to ensure that the social dimension is effectively addressed. This translates into measures to protect health, safety, rights and decent remuneration of workers. It also requires help and new opportunities for people that find themselves on the losing side of globalization (open markets unavoidably generate winners and losers).

Similarly, the connection between trade and environment needs to be strategically targeted. As a powerful motor of economic development, international trade has made a substantial contribution to global prosperity. However, it has also been one of the main drivers of an economic model responsible for unprecedented environmental disruption, which compromises, in the long-term, the well-being of people and may even challenge the survival of civilization.

The WTO and the United Nations Environmental Programme (UNEP)²¹ explain that alternative trade approaches can help bridge relative differences in resource endowments across countries, supporting a more economically and environmentally efficient allocation of resources at a global level. International trade can help to disseminate technologies and replace outdated, pollution-causing solutions, thereby facilitating the establishment and expansion of markets for sustainable products; supporting the widespread adoption of sustainable agricultural practice, and facilitating market access for smallholders.

Economic growth, challenges and transformation

Considering the evolution of trade as an enabler for the SDGs, and particularly from the perspective of developing countries, we can identify three major challenges.

The first concerns integration with the global market, notably participation in global value chains (GVCs) and access to export markets for agricultural and food products (particularly important for developing countries).

Participation in GVCs is imperative for economic development – indeed they structure today’s globalized economy. Competition has shifted from organized

²¹ Report listed under footnote 2.

production systems within nations to transnational GVCs. Comparative advantage has therefore moved from mastering the full cycle of production of a particular product, to mastering specific stages of the production chain, with their intermediate deliverables, within a transnational GVC.

Participation in GVCs provides an opportunity for suppliers to move to higher value-adding activities, to acquire knowledge and to obtain access to more advanced technologies – supporting the dissemination of organizational and technological know-how into the country where they are based.

Being able to integrate with GVCs, however, is not easy and requires higher levels of knowledge and intelligent policies to succeed. The WTO has found that developing countries face many barriers in seeking to join in GVCs, including inadequate infrastructure and customs barriers.

Regarding agricultural and food products, the WTO²² highlights the impact that trade-related fixed costs play in agricultural trade, notably the cost of implementing sanitary and phytosanitary (SPS) measures related to food safety and animal and plant health. The WTO notes that the number and complexity of standards in international food trade have increased in recent years and these measures can seriously hamper trade, even if they pursue valid policy objectives.

The second major challenge concerns the social dimension of trade. Ensuring that the benefits of trade are inclusive – shared among the various components of society, especially the poorest – should be a primary concern at national and international level. In this respect, three issues need to be addressed:

1. The pattern of trade-driven growth across sectors²³ is very important and in many developing countries a focus on rural areas, where most poor people are concentrated, is essential. This requires adequate policies to support rural development and more balanced approaches to urbanization
2. Decent working conditions for workers in trade-driven sectors – and notably in GVCs – should be ensured as a way to promote dissemination of fair labour practices. This is not easy: “There is a risk that global pressures on producer prices and delivery times and intense competition between suppliers may place downward pressure on wages, working conditions and respect for the fundamental rights of the workers participating in the chains.”²⁴ Application of international labour standards, a variety of instruments at national level (e.g. regulations, incentives, voluntary agreements) and the adoption of socially

²² World Trade Organization, “World Trade Report 2014, Trade and development: recent trends and the role of the WTO”. World Trade Organization: Geneva.

²³ Same publication ref. in note 4 (WB and WTO, 2015).

²⁴ ILO, “Decent work in global supply chains”, 2016.

responsible practices by multinational companies are among the possible solutions

3. Open-trade policies should be accompanied by social security measures and policies promoting participation (such as education, access to financial services, stronger governance) compatible with the resources available within countries

The third major challenge concerns the environmental dimension of trade. 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.²⁵

Trade is also responsible for shifting environmental disruption deriving from extraction of materials and “dirty” production processes to exporting countries, usually developing or emerging economies, which often lack technologies and resources to control pollution.

In relation to environmental goals, international trade can provide important contributions by:

- » Substantially reducing its own primary and direct impact on the environment, which concerns transport – by increasing the energy efficiency of carriers and pursuing decarbonization²⁶ – switching cargo transport to rail, redesigning and optimizing trade routes at various scales and offsetting carbon emissions
- » Helping to match the global supply and demand of goods produced where it is most environmentally efficient to do so – and based on a full product life cycle assessment
- » Supporting the widespread distribution of environmentally sound technologies and services stimulating and accelerating the development of sustainable industry and infrastructure
- » Fostering the development of GVCs for environmental goods
- » Facilitating the creation and expansion of markets for sustainable products, across many sectors – with a special attention on products from sustainable agriculture (of particular importance for developing countries)

These important contributions are not spontaneously delivered by trade – but can be obtained through the implementation of a variety of measures. In this respect, national policies are of fundamental importance. Trade development should be linked to environmental and social goals.

A recent WTO report²⁷ concluded that because trade has so many crosscutting effects within an economy and its diverse sectors, it is important that governments feed their trade policies into their national development

²⁵ OECD, “Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading”, Paris, 2018.

²⁶ See e.g. the IMO “initial strategy”, 2018.

²⁷ WTO, “Mainstreaming trade to attain the sustainable development goals”, Geneva, 2018.

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.

Coherent policies can be applied at the sector or thematic level. For example, energy efficiency regulations (for buildings, transport and manufacturing plants) and incentives to renewables (such as feed-in tariffs for electricity generated from renewable sources) can be combined with facilitating import of photovoltaic (PV) equipment. In addition, encouraging local companies to master such technologies can nurture champions in the implementation of solar PV installations at various scales – which may lead to export services in this area – and/or integration of local companies in GVCs dealing with this type of equipment.

WTO and UNEP²⁸ also highlight that, “the idea that trade can encourage domestic producers to become more sustainable has backing from several studies. Higher environmental standards abroad have been found to give export-oriented companies a strong incentive to upgrade their production to meet the higher (foreign) standard. Sometimes those companies may even push their own government to adopt the higher standard domestically while they develop the capability to meet it. This phenomenon has been referred to as the ‘California effect’, after the role that the state has played in raising regulatory standards in the United States”.

Participation in markets for sustainable products, particularly in the agricultural sector, can be supported by encouraging the adoption of sustainability schemas and certifications – an aspect directly related to quality infrastructure.

International agreements and cooperation are also very important. The WTO and UNEP²⁹ underline the increasing recognition of trade policy as a tool for supporting environmental protection and sustainable development – noting, for example, that an increasing number of regional trade agreements (RTAs)³⁰ contain environmental provisions. These take the form of “commitments” to “improve”, “adopt”, “harmonize”, “effectively apply”, “not waive” or “not relax” environmental laws.

The role and results of QI

International trade requires that transactions take place between countries, often with different regulatory traditions and regimes. Through its linkages with international institutions and associated networks of

²⁸ WTO and UNEP, 2018 (see footnote 2).

²⁹ Ibid.

³⁰ According to the WTO, there are 291 RTAs notified to the WTO and still in force on 31 December 2018. Available at: https://www.wto.org/english/tratop_e/region_e/region_e.htm



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.

TRADE: A ROUTE TO PROSPERITY FOR PAKISTAN

Under the framework of the Trade-Related Technical Assistance (TRTA) programme (funded by EU and UNIDO), UNIDO's contribution focused on export development through the improvement of quality infrastructure.

From 2010 till 2016 UNIDO facilitated the successful development of a quality infrastructure in Pakistan which met international requirements and gained full recognition by its international peers. Through the support of TRTA, Pakistan today has a national quality policy, an accreditation body, as well as more than 40 product testing and metrology laboratories that can globally testify the standards compliance of national products while at the same time better protect local consumers. Impressive results were achieved in promoting export products from Pakistan in international markets, such as fishery products, among others. This export success is a powerful driver for more economic growth and further creation of employment for Pakistan's men, women and youth.

The impact of the strengthened QI, through the project activities for fisheries products, include:

- » Resumption of fisheries exports to the EU in March 2013
- » 160 consignments to the EU valued at Euro 14.3 million
- » Zero rejection since resumption of exports until the project end

The following scenarios highlight the steps that a company wishing to access the market with a product or service is often required to take:

- » A company wishing to sell to domestic clients needs to ensure that its products or services meet national legal or regulatory requirements that protect consumers and 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 resources required to address them. 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 and trusted evidence of conformity to these requirements. As stated previously, this is even more so where food and other agricultural products are concerned because strict sanitary and phytosanitary (SPS) rules often apply.

It is important to note that these 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.

Market access: participation in global value chains	<ul style="list-style-type: none"> » Ensure accuracy and comparability of results » Support domestic participants to integrate with more complex production systems, requiring: <ul style="list-style-type: none"> » Harmonization of processes, materials and instruments; as well as tools and methods used in R&D and production, with those of the other participants in the chain (notably the lead buyers) » Help domestic participants to build trust with the other participants in the chain, concerning: <ul style="list-style-type: none"> » Reliability of the legal and technical infrastructure within which they operate » Demonstration of conformity to international standards and other standards or proprietary requirements set by buyers
Domestic market: consumer and environmental protection	<ul style="list-style-type: none"> » 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 and comply with suitable technical regulations and/or to support the adoption and use of voluntary standards » 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

Source: UNIDO

The WTO Agreement on Technical Barriers to Trade (TBT) acknowledges the role of technical regulations, standards, and conformity assessment 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 Agreement is primarily about technical regulations, standards (which are voluntary by definition in the TBT Agreement) have an important role in the framework of the agreement.

WTO's members are expected to use international standards (whenever they exist, or their completion is imminent) as a basis for technical regulations – and technical regulations in accordance with relevant international standards are not deemed to constitute an unnecessary obstacle to trade.

The agreement requires that its members use relevant international standards, guides or recommendations for conformity assessment procedures as a basis for their own procedures for a positive assurance of compliance with technical regulations and standards. The requirement for international standards also applies to ensuring the technical competence of CABs, when negotiating on the conclusion of mutual recognition of conformity assessment results of each other's procedures.

Similarly, the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) encourages governments to establish national SPS measures consistent with international standards, guidelines and recommendations. In general, national SPS measures based on such international standards are not deemed to constitute unnecessary trade obstacles, according to the SPS Agreement. The TBT Agreement specifies a code of good practice which members must also implement in the preparation, adoption and application of standards.

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 trade practices and procedures that do not comply to the WTO TBT and SPS agreements 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).

Key contributions expected from a national or regional QI

Context	Contribution of quality infrastructure
Market access: access to export markets (for final products or self-standing product components)	<ul style="list-style-type: none"> » 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), acceptability of test results » Support continual improvement of exporters' products and processes » Provide up-to-date and reliable information to exporters regarding target markets » Enable exporters to achieve compliance with regulations (mandatory requirements) of target markets » Help exporters to meet expectations (quality requirements) of target markets

Governmental 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 MRAs. An MRA is a binding agreement under which one country, or trading block, agrees to recognize certificates issued by designated bodies in a second country or trading block as a basis of compliance with its own regulations related to product safety and quality assurance.

The impact of such agreements can be significant. For example, manufacturers located in one country and exporting to another country can arrange that all testing, inspection and certification of their products is undertaken in their home country, with the certainty that the relevant testing and inspection reports and certificates will be recognized by the regulatory authorities in the export destination country.

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”, making it easier for businesses to access and sell to customers in many other parts of the world.

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 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 improve their national quality infrastructure.

Much cooperation aimed at facilitating trade is now occurring at the regional level. Regional trade agreements (RTAs) encourage participating member countries to consider what is needed both individually and collectively to ensure the effective implementation of these agreements. They can also create new possibilities for expanding trade cooperation and advancing the achievement of the SDGs. Such agreements can also provide strong incentives to improve the associated national QI at regional level, to fully generate benefits from these agreements.

The establishment of equivalent and trusted QI capabilities helps to create a level playing field for all businesses in the region to compete. Regional cooperation can take the form of broader economic groupings that promote, for example, regional solutions to the establishment of an effective QI.

ESTABLISHMENT OF A REGIONAL QUALITY POLICY IN CENTRAL AFRICA

One of the results achieved by the UNIDO-implemented Quality Infrastructure Programme for Central Africa (PIQAC) was the development of a regional quality policy. A detailed mapping of the existing quality infrastructure institutions was carried out at the national and regional levels.

An action plan for the implementation of the regional quality policy was elaborated and adopted by the seven beneficiary countries of the programme. These beneficiary countries included: Cameroon, the Central African Republic, Chad, the Republic of Congo, Gabon, the Democratic Republic of Congo and Sao Tome and Principe. Regulatory texts concerning the implementation of the policy were also adopted.

The programme is creating a favourable business environment, while assuring compliance with international trade regulation laws and technical standards.

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 improvement in QI throughout that region. The Asia Pacific Laboratory Accreditation Cooperation (APLAC), a recognized region of the international body, 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.

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.

The path forward

Metrology, standardization and the associated conformity assessment procedures that, together, constitute quality infrastructure, are key enablers of international trade. However, they have conventionally been focused on addressing technical performance, durability and other quality-related aspects of products, including health and safety requirements. Today, they have a fundamental role to play in supporting the SDGs through the types of actions outlined above.

The key point is to extend the scientific and technical knowledge embedded in standards to cover environmental and social aspects of production activities and deliverables, and to leverage that knowledge, along with the rigorous and transparent processes of conformity assessment, to support policies and business practices aiming at steering trade for sustainability.

Trade agreements at bilateral, regional and multilateral levels, need to recognize and promote, existing and new, improved standards and conformity assessment schemes supporting products and services with a better environmental and social footprint.

Through voluntary measures, the private sector can also give a substantial contribution to sustainability in trade along value chains, by actively supporting, the exchange of environmentally and socially friendly goods, services and technologies.

International trade is not only an essential component of a developing country's path to prosperity but it can also be used to achieve many of the outcomes related to SDG 8. A sustainable national and regional QI provides fundamental enablers to support a country's aspirations related to, and participation in, international trade.

QI institutions and services can provide existing and new standards and conformity assessment procedures for materials and products that incorporate product life cycle assessments based on objective and internationally recognized criteria, standards for the design and operation of environmentally benign technologies and services, and environmental goods. GVCs can then be organized for these environmentally friendly goods, services and technologies.

Governments, the private sector (producers, suppliers and distributors), NGOs and consumer organizations need to work together to streamline or consolidate standards and certification frameworks for sustainable commodities and products. The aim is to create the conditions for easier, better informed decisions by consumers - facilitating the participation of suppliers, especially SMEs - and supporting the development of broader, equitable “glocal”³¹ (global/local) markets.

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 serious mistake – given the fundamental role that a better coordinated QI can also play in 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.

³¹ “Glocal”, a portmanteau of the words “global” and “local”, is an approach, which means presenting global knowledge within a local context. Available at: <https://www.scidev.net/global/communication/opinion/-glocal-approach-makes-global-knowledge-local.html>

In this regard, it is important to underline that the future development of national and regional QI capacity and capability needs to be geared towards ensuring:

- » Protection of public health and safety from sub-standard products, hazardous substances and pests. This should be seen as a top priority given that any gaps in these areas are likely to generate huge, but preventable, negative long-term impacts and costly corrective action.
- » Focus on preventing both export and import trade of sub-standard products.
- » 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.
- » Focus on the development of more sustainable infrastructures and industry.
- » Participation in international standards-setting and other QI-related organizations to ensure that the areas important to national priorities are monitored.
- » Assessment, with the support of the United Nations Forum on Sustainability Standards (UNFSS), of the legitimacy, trade and business impact and conformity assessment-related needs of voluntary sustainability standards.

UNITED NATIONS FORUM ON VOLUNTARY SUSTAINABILITY STANDARDS (UNFSS)

The UNFSS is a forum to provide information, analysis and discussions on voluntary sustainability standards at the intergovernmental level. UNFSS promotes proactive and strategic dialogue about national policies and experiences, as well as on meta-governance issues of voluntary sustainability standards (VSS) work towards:

- » Achieving the specific sustainability objectives of developing countries like reducing poverty, using natural resources sustainably and protecting ecosystems
- » Opening foreign markets
- » Lowering potential hurdles to development and access to markets
- » Averting the costs of compliance

The members of the UNFSS are FAO, ITC, UNCTAD, UNEP and UNIDO.



5. MEETING THE NEEDS OF PEOPLE

In the context of the SDGs, the “people” dimension focuses on the determination to end poverty and hunger in all their forms, and to ensure that all human beings can fulfil their potential in a healthy environment, in dignity and with equality.³²

5.1 Food and agriculture



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

SDG 2 calls for ending hunger and malnutrition and ensuring sustainable food production systems, implementing resilient agricultural practices that increase productivity and production, helping to maintain ecosystems and strengthening the capacity for adaptation to climate change.

It also calls for doubling the agricultural productivity and incomes of small-scale food producers, for maintaining the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, while correcting and preventing trade restrictions and distortions in world agricultural markets and adopting measures to ensure the proper functioning of food commodity markets in order to help limit extreme food price volatility.

Food, agriculture and prosperity for all

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 civilizations³³ 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.

The other major contributing factor to modern agriculture – the science of plant nutrition – was established around the same time through the work of German chemist Justus von Liebig and several other scientists. 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 completes the picture and 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 human 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 GDP contributed by agriculture.

The increases in agricultural output, combined with industrialization and the development of suitable transportation infrastructure, have 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.

Agricultural challenges and transformation

Modern agriculture, which started in industrialized countries, was extended to a substantial part of the developing world through the “Green Revolution”,³⁴ which has been instrumental in expanding global agricultural output and food production to levels unthinkable just a few decades ago.

Agribusiness and the global food industry have evolved into very complex and highly regulated fields, comprising interconnected systems of legislation, international collaboration and voluntary measures. Standardization and other QI components have played a fundamental role in supporting this evolution as enablers of agricultural productivity increase and, most importantly, of the health and safety of food products, plants and animals belonging to the food value chain.

These outstanding results have not, however, been enough to end hunger³⁵ and, globally,³⁶ “around one-

³⁴The Green Revolution refers to a technology transfer initiative targeting developing countries promoted by Nobel-prize winner Norman Borlaug and a variety of institutions, mostly from the USA. The Green Revolution started in Mexico and since the late 1960s and 1970s was broadly implemented in Asia, leading, in about 30 years, to double or eventually triple agricultural yield. The Green Revolution was essentially based on the selection and spreading of high-yielding varieties of wheat and rice, combined with intensive agricultural techniques, large-scale irrigation and massive use of fertilizers and pesticides.

³⁵ See: UN Sustainable Development Goals (2019). The number of people going hungry has increased since 2014. An estimated 821 million people were undernourished in 2017 (representing about 11 % of the world population) Available at: <https://www.un.org/sustainabledevelopment/hunger/>.

³⁶ FAO, “The Future of food and agriculture – Trends and challenges”, 2017.

³² SUN (2015).

³³ See e.g. Jared Diamond, “Collapse: How Societies Choose to Fail or Succeed”, 2005.

third of all food produced is lost or wasted along the food chain, from production to consumption. In a world where hundreds of millions of people go hungry, that is a stark indication of the inefficiency of current food systems”.

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, fertilizers and pesticides
- » Dependency on oil and gas to power machinery and produce the most widely used fertilizers and pesticides

In many cases, this set of interrelated activities has also been responsible for creating environmental disruption (e.g. deforestation), soil degradation (e.g. due to the tilling and irrigation practices of intensive agriculture) and pollution (e.g. 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 as 25 % according to the International Plant Protection Convention (IPPC), which paradoxically creates major challenges for the future of agriculture.³⁷

In addition, while in most high-income and middle-high income countries, QIs, regulatory frameworks and other policies ensure the health and safety of food products, in many developing countries the situation is often very different due to factors such as those outlined below.

- » Food-borne diseases are still 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 each 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 human, financial and technical resources 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

It is against this backdrop that the urgent call for action of the SDGs has to be fulfilled – considering

³⁷ IPCC (2014), Climate Change 2014 Synthesis Report. Available at: https://ar5-syr.ipcc.ch/ipcc/resources/pdf/IPCC_Synthesis-Report.pdf

that many SDGs are directly or indirectly linked to food and agriculture (along with SDG 2, notably SDG 1, SDG 3, SDG 6, SDG 9, SDG 13, SDG 15 and SDG 14).

The role and results of QI

In all developed and in some developing countries, central national authorities³⁸ are the primary actors responsible for the legal framework applicable to food products and its enforcement – often complemented by specialized agencies or local authorities³⁹. Examples of legal frameworks are the Food Standards Code of Australia and New Zealand (2003), the US Food Code (2017), the European General Food Law Regulation (2002) or the PRC Food Safety Law (2015).

These legal frameworks provide a comprehensive set of mandatory requirements, rules and modalities of compliance for:

- » Health, safety and quality of food products
- » Requirements for processing, production, packaging, storage and delivery of food products
- » Agricultural inputs directly related with human health and safety, such as animal feed and use of antimicrobial agents, and the use of fertilizers and pesticides
- » The definition of ingredients, information on and labelling of food products; classification of origin, and traceability along the value chain

These rules must be observed by any supplier of food products operating in the country, including importers to the country.

Agricultural practices are usually under the responsibilities of ministries, although specific issues are often at the intersection of responsibilities of ministries of agriculture and central authorities for food matters. Agricultural equipment and practices are mainly covered by voluntary standards (international, national or sector-based) and related mechanisms of conformity assessment, whenever applicable. They usually cover aspects such as:

- » Equipment supporting agricultural activities - 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 components
- » Seeds, animal feed and agricultural inputs such as fertilizers, if they are not directly related to human health
- » Guidance on agricultural practices

³⁸ In the European Union a harmonized set of legal requirements are applied by all member states, although a number of specific provisions are under the autonomous responsibility of the latter

³⁹ For example, in the USA the Food and Drug Administration is the federal authority responsible for food matters but there are a few thousand local, state, and other federal governmental jurisdictions that have or have been delegated compliance responsibilities for food service, retail food stores, or food vending operations.

ESTABLISHING QI BEST PRACTICES IN THE PERUVIAN COFFEE SECTOR

UNIDO technical assistance promotes a national culture for quality, and improves 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 for better market access.

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.

The most important among them is the UN Food and Agriculture Organization (FAO), a specialized UN agency that leads international efforts to defeat hunger. The FAO provides a forum to developing and developed countries to address global and regional issues concerning food and agriculture, to define policies and negotiate agreements. FAO departments cover all the principal human activities regarding the use of land and water for food production and other ecosystem services, including agriculture and consumer protection, fisheries and aquaculture, and forestry activities.

The FAO is a source of research and knowledge in these areas and runs programmes⁴⁰ aiming to improve agricultural practices, to support developing countries’ modernization of agriculture, and to protect the environment and the transition towards sustainable agriculture.

In addition, three important intergovernmental organizations described below provide international standards and guides concerning food products and processes, as well as plant and animal health. The standards provided by them are voluntary – but they can be used by member states as a basis for national legislation. These organizations are officially recognized as providers of international standards by the WTO SPS Agreement.⁴¹ This agreement encourages

⁴⁰ A number of FAO specific programmes are referenced in other sections of the publication, e.g. “Life on Land and below Water”.

⁴¹ See: https://www.wto.org/english/tratop_e/sps_e/spsund_e.htm

governments to establish national SPS measures consistent with international standards, guidelines and recommendations. In general, national SPS measures based international standards are deemed by the WTO not to constitute trade barriers.

The Codex Alimentarius Commission (CAC) was established by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) 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 agreement established by FAO member countries. 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 develops international standards for phytosanitary measures (ISPMs) for safeguarding plant resources. These address pest surveillance and monitoring, import regulations and pest risk analyses, 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.

Another important intergovernmental organization providing standards and compliance procedures in the field is the Organization for Economic Cooperation and Development (OECD). In particular, the OECD provides agricultural codes and schemes⁴² – for seeds, forests, fruit and vegetables and tractors to facilitate international trade through the simplification and implementation of international standards. OECD’s codes and schemes are open to any OECD or non-OECD country that is a member of the UN or of the WTO. Its Seeds Scheme is the most important and broadly applied.

The picture is completed by a multitude of organizations that provide other voluntary standards for the food

⁴² See <http://www.oecd.org/tad/code/>

industry and agribusiness, including the International Organization for Standardization (ISO) and the Global Food Safety Initiative (GFSI).

The ISO is an important developer of standards for agricultural equipment (notably machinery and irrigation equipment), as well as an organization complementary to the CAC and the other organizations mentioned above. The ISO provides hundreds of international standards (developed by the ISO Technical Committee 34, Food products) covering characterization of substances and test methods applicable to determine properties of food commodities, or concentration and limits of chemical and natural substances in food. In addition, the ISO 22000 series provides a broadly applied platform supporting food safety management.

The GFSI is the leading global business-led initiative addressing food safety standards and certification schemes applied by major international retailers, food service chains, and manufacturers.⁴³ GFSI was established “to deliver equivalence and convergence between effective food safety management systems through its benchmarking process. Benchmarking is a procedure by which a food safety related scheme is compared to the GFSI Guidance Document. The benchmarking process determines equivalency against an internationally recognized set of food safety requirements, based on industry best practice and sound science”.⁴⁴

GFSI is not a certification programme in itself, nor does it carry out any accreditation or certification activities. Certification to a GFSI recognized certification scheme such as the Food Safety Management System Scheme FSSC 22000, BRC (British Retail Consortium), or GLOBALG.A.P., can be achieved after a successful third-party audit conducted against any of the various food safety requirement standards that have been benchmarked and recognized by the GFSI. Any such certification is then, in principle, accepted by all GFSI member purchasing organizations.

The path forward

The QI institutions and the services they provide already have a fundamental role in the support of food safety, trade in food and agricultural products and a practices.

⁴³ Among the major food safety schemes recognized and benchmarked by GFSI are: the British Retail Consortium Global Food Standard (BRC); the Independent Foundation FSSC 22000 Food Safety System Certification standards (FSSC 22000, based on the ISO 22000 series); Global Red Meat Standard (GRMS); International Featured Standards (IFS Standards); GLOBALGAP, and Safe Quality Food Institute's SQF food safety standards (SQF Codes).

⁴⁴ GFSI (2014), “Global Food Safety Initiative (GFSI) Recognises BRC Scope Extension for Storage and Distribution”. Available at: https://mygfsi.com/press_releases/global-food-safety-initiative-gfsi-recognises-brc-scope-extension-for-storage-and-distribution

STRENGTHENING QI FOR MYANMAR'S FOOD SUPPLY CHAIN

UNIDO provided support to Myanmar, where the national quality infrastructure lacked the capacity required for a modern economy with food supply chains integrated into global 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/IEC 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, 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.

They now need to evolve to facilitate the development of sustainable agriculture. There are many areas where QI services can be extremely important. These include:

- » General good practice for sustainable agriculture⁴⁵ – which promotes a systems perspective, integrating the activities of individual farms with the ecosystem in which they operate and the communities affected at local and global levels
- » Standards, chemical metrology, testing and inspection procedures addressing methods and technologies for sustainable agriculture, such as soil management,⁴⁶ irrigation and water management,⁴⁷ and integrated pest management⁴⁸
- » Standards and resources for the development and conservation of plant genetic resources (PGR) –

⁴⁵A key international reference is the FAO's “Sustainability Assessment of Food and Agriculture systems (SAFA) Guidelines”. Other examples are the Sustainable Agriculture Network (SAN) “Sustainable Agriculture Framework”, the Rainforest Alliance “Sustainable Agriculture Standard”.

⁴⁶See e.g. FAO, “Voluntary Guidelines for Sustainable Soil Management”, 2017.

⁴⁷ See e.g. ISO standards covering Water quality (ISO TC 147), guidelines for treated wastewater use in irrigation projects from ISO/TC 282, Water re-use, or the ISO International Workshop Agreement (IWA 20:2017) on drip irrigation.

⁴⁸See e.g. the online database on pesticides and Integrated Pest Management (IPM), developed and promoted by the ISEAL IPM Coalition. The IPM Coalition is made up of 9 organizations who aim to promote integrated pest management (IPM) and to reduce or eliminate the use of highly hazardous pesticides. (The IPM coalition efforts are supported by several other organizations, such as CABI, the Centre for Agriculture and Biosciences International).



such as the Genebank Standards for plant genetic resources for food and agriculture⁴⁹

- » 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 agriculture⁵⁰
- » Multi-stakeholder voluntary sustainability standards, 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.

Agriculture is an essential sector, especially 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 presents daunting and diversified challenges. For countries with large populations and limited agricultural land, it is indispensable to achieve high crop productivity and efficient use of resources in order to feed their citizens without harming the environment. For the least developed countries, the overarching goal is to eradicate hunger and to secure adequate nutrition for all people, especially children. For a significant number of developing countries, further challenges concern the need to improve control systems of food products to ensure they are fit to eat and nutritious.

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

- » The improvement of health and increased safety of food products that will require development and strengthening of national and regional quality QIs
- » Active participation in international activities coupled with synergistic collaborations at the regional level
- » Development and promotion of sustainable agriculture, following the strategic directions outlined in the previous section
- » Activities and programmes for the dissemination of information, capacity building and supportive and affordable QI services

It must be emphasized that the single most important development for the majority of developing countries concerns targeted policies and actions for family farming. “More than 500 million family farms form

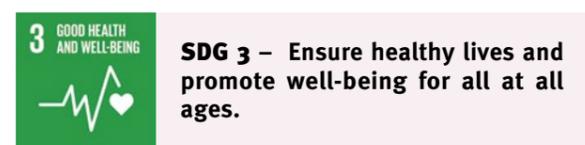
⁴⁹FAO, “Genebank Standards for Plant Genetic Resources for Food and Agriculture”, revised edition, 2014.

⁵⁰The European Environmental Bureau (EEB), “Position Paper on the Future of CAP”, 2017.

the backbone of agriculture in most countries. Family farms represent more than nine out of 10 farms in the world and can serve as a catalyst for sustained rural development. They are the stewards of the world’s agricultural resources and the source of more than 80 % of the world’s food supply, but many of them are poor and food-insecure themselves.”⁵¹

Promoting innovation for family farming, helping to increase productivity while protecting the environment and preserving communities, are essential for inclusive and sustainable development.

5.2 Good health and well-being



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 advocates 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.⁵²

Population growth, longer life expectancy, increasing international travel and trade, as well as innovations in modern medicine are placing an ever-growing demand on healthcare systems. Government authorities mandated to protect the health and safety of citizens need the support of QIs. They also need to work together with others to fulfil their 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 conformity assessment bodies to underpin health and safety-related requirements and regulations is therefore critical.

Health and prosperity for all

Health contributes to and also benefits from many other SDGs in major ways. A healthy workforce is more productive and healthy children learn better. Healthcare influences life expectancy. On the contrary, unsafe drinking-water or sanitation, pollution, and poor housing damage health.

⁵¹FAO, “The State of Food and Agriculture, Innovation in family farming”, 2014.

⁵²See UN Sustainable Development Knowledge Platform portal. Available at: <https://sustainabledevelopment.un.org/sdg3>

Health, along with education, is an essential component of “human capital”. “By improving their skills, health, knowledge, and resilience – that is their human capital – people can be more productive, flexible, and innovative. Human capital is a central driver of sustainable growth and poverty reduction. Investments in human capital have become more important as the nature of work has evolved.”⁵³

However, it is also clear that “despite substantial progress, significant gaps in human capital investments are leaving the world poorly prepared for what lies ahead”; in this respect, SDG 3 (along with SDG 4, quality education) represent a universal call for action to fill those gaps.⁵⁴

The structure and organization of healthcare vary widely across countries. Local social and cultural norms and economic conditions strongly influence the way in which healthcare is supplied. Improving human health and providing access to affordable, high quality healthcare is especially important for developing countries where many people are poor and have limited or no access to basic healthcare.

While there is no universal model of delivering services, the societal value of any healthcare system depends on its capacity to benefit citizens. 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.

Healthcare systems apply inputs (equipment, supplies, and staff) to processes or activities (treatments and other interventions, patient care), from which health outcomes result. This system view frames the analysis attempted here to highlight some of the challenges and opportunities for improving healthcare, especially in developing countries.

Healthcare challenges and transformation

The establishment and operation of an effective and efficient healthcare system is a daunting task, especially for developing countries. Supporting its development to meet society’s evolving needs, and emerging challenges, further complicates the matter.

The most important challenge concerns the awareness and understanding of today’s broader concept of healthcare and applies to all countries - although with their specificities and priorities.

Dr. Jonathan Patz⁵⁵ noted: “The former acting Surgeon General of the United States said that ‘the USA. does not have a healthcare system, we have a sick care system’. His point was a healthcare system means safe routes to school, clean air, clean water, cities that are designed to promote physical fitness and mental

⁵³The World Bank, “The Human Capital Project”. Available at: <https://openknowledge.worldbank.org/handle/10986/30498>

⁵⁴Ibid.

⁵⁵Director of the Global Health Institute, University of Wisconsin-Madison (USA).

health. That’s where we need to understand health in its fully integrated way and not just be a sick care system with hospitals and clinics, but really design a healthy society.”

A second global challenge relates to climate change and pollution. Again, this concerns all people, although there is a disproportionate impact on the world’s poorest. According to the WHO, nine out of 10 people breathe polluted air every day. In 2019, air pollution is considered by WHO as the greatest environmental risk to health and the primary cause of seven million premature deaths every year.⁵⁶

A third global challenge concerns antimicrobial resistance (AMR). “Antimicrobial resistance – the ability of bacteria, parasites, viruses and fungi to resist these medicines – threatens to send us back to a time when we were unable to easily treat infections such as pneumonia, tuberculosis, gonorrhoea, and salmonellosis. The inability to prevent infections could seriously compromise surgery and procedures such as chemotherapy”.⁵⁷ AMR is driven by the overuse of antibiotics on people and on the environment, but above all on animals, especially those used for food production.

A fourth global challenge concerns the ability to respond to health emergencies, including pandemic influenza and high-threat pathogens – such as Ebola and the Severe Acute Respiratory Syndrome (SARS) – which, given the nature of today’s globalized world, can spread at incredible speed across countries.

A fifth global challenge – also an opportunity – is the development of digital health. The potential is universally recognized that “digital technologies have to advance the Sustainable Development Goals, and in particular to support health systems in all countries in health promotion and disease prevention, and by improving the accessibility, quality and affordability of health services.”⁵⁸

In addition, developing countries face specific challenges:

- » **Universal health coverage (UHC):** This includes financial risk protection, access to essential healthcare services and access to safe, effective and affordable medicines and vaccines for all⁵⁹
- » **Funding:** To secure adequate funding to support population needs is a challenge for all countries – although for rich countries spending on health remains relatively high, whilst many developing countries and especially low-income countries, struggle to provide access even to basic health services⁶⁰

⁵⁶WTO, “Top threats to global health”, 2019. Available at: <https://www.who.int/emergencies/ten-threats-to-global-health-in-2019>

⁵⁷WTO, “Top threats to health”, 2019. Available at: <https://www.who.int/emergencies/ten-threats-to-global-health-in-2019>

⁵⁸Resolution of the 71st World Health Assembly, 2018. Available at: http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_R7-en.pdf

⁵⁹Under specific target 3.8 of SDG 3.

⁶⁰See WHO’s pages re: financing for universal coverage. Available at: https://www.who.int/health_financing/strategy/revenue_col-lecton/en/

- » **Primary healthcare:** “Primary healthcare is usually the first point of contact people have with their healthcare system, and ideally should provide comprehensive, affordable, community-based care throughout life”.⁶¹ Weak primary healthcare facilities are one of the top threats to health listed by the WHO and strengthening primary health is a key strategic area for a large number of countries
- » **Food poisoning:** According to the WHO,⁶² “Every year, 600 million people – almost one in 10 people in the world – all ill and 420,000 die after eating contaminated food.” This is a challenge that, together with antimicrobial resistance (AMR), is one where QIs can be particularly useful
- » **Malnutrition.** Globally, 45 % of deaths among children under five are linked to undernutrition. This is a huge challenge in the least developed countries, especially in sub-Saharan Africa

The role and results of QI

QI institutions and services provide a fundamental contribution to healthcare and help to address the challenges outlined above by means of:

- » Standards and regulations for medical equipment and medicines, food safety, management and quality assurance of healthcare facilities, good practices for emergency management and prevention of antimicrobial resistance
- » Conformity assessment procedures aiming to verify, assess and demonstrate compliance with relevant standards and regulations in all these areas

In the following, we focus our attention on inputs and processes, providing an overview of the other aspects under “The path forward”.

Inputs

Both medical equipment and medicines depend on accurate measurement, standards and conformity assessment practices for their effectiveness. Many devices used in hospitals and in medical laboratories need periodic measuring in order to produce consistent and reliable results within known margins of error – this is known as calibration. The testing and control of pharmaceutical products are also essential to ensure that patients receive high standard quality medicines, and to prevent the infiltration of substandard and counterfeit medicine into the supply system.

From manufacturing standards and quality assurance systems at production sites to control systems which governments can operate at the border and in the

domestic market, QI provides the necessary tools for ensuring that medical devices are safe and fit-for-purpose.

The sharing of good practice and international standardization has made universally available information about effective and internationally recognized production management systems and regulatory policies.

IDENTIFYING HAZARDS TO MEDICAL DEVICES

ISO 14971 specifies a process for a manufacturer to identify the hazards associated with medical devices, including in vitro diagnostic (IVD) medical devices, to estimate and evaluate the associated risks, to control these risks, and to monitor the effectiveness of the controls – defining best practices throughout the entire life cycle of a device.

Risk management is a key component in demonstrating regulatory compliance for medical devices. For example, in 2012, a European harmonized version of this standard was adopted by the European Committee for Standardization (CEN) as EN ISO 14971:2012. This version is harmonized with respect to the three European directives associated with medical devices: Active Implantable Medical Device Directive 90/385/EEC, Medical Devices Directive 93/42/EEC, and In-vitro Diagnostic Medical Device Directive 98/79/EC.

In addition, the European medical device directives require manufacturers to implement a quality management system, for which the harmonized standard is EN ISO 13485:2012. This standard also details requirements for demonstration of risk management.

Other standards applicable to the industry and covering specific aspects such as electrical safety and electromagnetic compatibility and non-interference with the radio spectrum, have been developed by IEC and ITU.

Products and services for healthcare are subject to stringent regulatory requirements and supervisory regimes. However, to prevent inefficiencies, reduce transaction costs and avoid unnecessary barriers to trade, international cooperation among public authorities in this area has evolved significantly since the 90s. Collaborations in the field of medical devices, which range from basic items such as sterile, single-use syringes or mechanical contraceptives, to all types of patient-screening and intervention equipment are highlighted in the accompanying box.

Systems and policies in place to ensure safety, reliability and performances of medical devices are routine in the developed world, where the production of much of the medical equipment and sales markets are concentrated, but need to be promoted also in developing countries, where regulatory controls are not always strong.



⁶¹ WHO, top threats to health 2019.

⁶² WHO, top threats to health 2018.

IMDRF – INTERNATIONAL MEDICAL DEVICES REGULATORS FORUM

The International Medical Device Regulators Forum (IMDRF) was conceived in February 2011 as a forum to discuss future directions in medical device regulatory harmonization. It involves regulatory authorities of the major markets for medical devices, including EU, USA, Australia, Brazil, Canada, China and Japan, Russia, Singapore and South Korea.

The IMDRF is the successor of the Global Harmonization Task Force (GHTF – established in 1993 as an international partnership between medical device regulatory authorities and the regulated industry, aiming to achieve harmonization in medical device regulatory practices).

The IMDRF works in a number of important areas, including:

- » Regulatory exchange of relevant post-market safety information on medical devices (aiming to trigger rapid safety corrective actions)
- » Implementation of a globally harmonized approach to uniform device identification systems
- » Development of a standard set of requirements for auditing organizations performing regulatory audits of medical device manufacturers' quality management systems
- » Maintenance and expansion of the list of International Standards, used for medical device regulatory purposes, that are recognized by IMDRF Management Committee members

Developing countries operate health services under tight budgets and often procure equipment, including refurbished equipment, paying attention to costs, but not necessarily to quality. There is a vast body of reference material, including the WHO Medical Device Regulations guide (2003) that countries can use to set up national regulatory systems and improve on them. One of the priorities identified is establishing supplier and product registrations.

There is also a need for simpler medical devices. Developing countries need basic, low-maintenance equipment - much of the donated equipment they receive is not used because hospitals do not have the trained personnel. By one account, only 10-30 % of donated equipment is actually used, the reasons being due to mismanagement in the acquisition process, a lack of user training and a shortage of effective technical support.⁶³

The other major input to healthcare – medicines - must

⁶³WHO, "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.

also meet stringent 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 regularly updated by the WHO, and mandated to elaborate global standards and guidelines for the quality, safety and efficacy of medicines.⁶⁴

The WHO also maintains a list of essential medicines along with recommended dosage details. The products appearing on the list are mostly off-patent cheaper generics, although over time several newer patented medicines for treating HIV and other diseases have been added. The list is intended as a guide for national health authorities to develop their own lists of medicines considering the specific disease burden of their country. In 2017 the list included 477 drugs.⁶⁵ As of 2016, some 155 countries maintained national lists based on the WHO's model list.⁶⁶

To the extent that global manufacturers of generic medicines take market shares away from patented brands, this offers further scope for buying medicines at lower prices.

A very important contribution of QI to lower prices comes through efforts to remove unnecessary transaction costs created by the regulatory requirements of selling pharmaceuticals in different markets. As in the case of medical devices, entry into each market usually requires separate regulatory approval and for new medicines this 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. That this can be done illustrates the work of the International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH). Here, regulatory authorities and pharmaceutical industry experts work together to harmonize the global scientific and technical aspects of national drug registration.⁶⁷

Processes

Health outcomes depend vitally on the quality of services that are offered by hospitals, providers of primary care and medical laboratories.

⁶⁴ See WHO site. Available at: http://www.who.int/medicines/areas/quality_safety/quality_assurance/norms_standards/en/

⁶⁵ WHO, "Essential medicines and health products". Available at: https://www.who.int/medicines/services/essmedicines_def/en/

⁶⁷ The work accomplished by ICH so far include a harmonized format of registration application which industry applicants for registering their drug submit to regulatory authorities, harmonization in the interpretation and application of technical guidelines and requirements for product registration, and good practice guidance for the review of applications. See ICH website and its main publication. Available at: http://www.ich.org/fileadmin/Public_Web_Site/ABOUT_ICH/Vision/Value_Benefits_for_Regulatory_2010.pdf

ISO 15189: MEDICAL LABORATORIES AND ACCREDITATION

Medical laboratory services are essential in the diagnosis and assessment of the health of patients, and encompass arrangements for requisition, patient preparation, patient identification, collection of samples, transportation, storage, processing and examination of clinical samples, together with subsequent results validation, interpretation, reporting and advice.

Results need to be accurate, timely, linked to the correct patient and processed with respect for ethics, confidentiality and the safety of the patient. Accreditation to the internationally recognized standard ISO 15189 enables laboratories to demonstrate their competence to deliver these services reliably.

Quality assurance has been a part of healthcare for the past 100 years. It was introduced into modern medicine by a British nurse, Florence Nightingale, who assessed the quality of care in military hospitals during the Crimean War. When she introduced the first standards in nursing care, mortality rates in hospitals dropped dramatically.⁶⁸

An essential objective of quality assurance is to maximize the effectiveness and efficiency of the existing system and organizations. This gives governments, public and private healthcare providers and communities the possibility to realize more benefits from the existing investments in healthcare.

Consistent high performance to acceptable standards is the cornerstone of quality assurance in healthcare. Standards of care can be developed by different stakeholders, including hospitals themselves or health ministries. Professional organizations, the WHO and accrediting organizations are developing and updating consensus standards and guidelines for healthcare professions and hospitals and other organizations. These documents and their translation into operational criteria against which performance is evaluated are the work of healthcare experts. They reflect state-of-the-art thinking about healthcare quality, advances in technology and treatments, and changes in health policy. More and more innovative IT-based approaches for managing patient data and delivering healthcare services are becoming available, such as remote diagnostics and robotics in health and medical care. Standardization and quality assurance programmes will have to take all these changes into account.

The range of quality assurance activities is wide and only one type, accreditation by a healthcare accreditation body, will be presented here with the aim to illustrate how this QI service finds application in the

⁶⁸ Lori DiPrete Brown et al, "Quality assurance of health services in developing countries", Bethesda, Maryland, undated. Available at: <http://www.qaproject.org/methods/resdefin.html>

health sector.⁶⁹ Such accreditation is voluntary in most countries and it complements national minimum legal requirements for public safety, requiring that in order to operate and provide care or services, hospitals and other establishments must be licensed (accredited).

Governments or regulatory authorities grant these licenses when facilities meet defined minimum levels of quality or provide certain services, e.g., surgery, round-the-clock nursing care, pharmacy services, and laboratory services. Voluntary accreditation programmes are attractive to health insurance providers as a way of defining which institutions may participate in their programmes, and they appeal to governments seeking to provide universal health coverage because this permits them to use independent professional surveys to make sure that financing for healthcare services is provided only to facilities that meet a high standard of care.⁷⁰

There are many organizations that offer external evaluation and/or accreditation services, specializing in different fields of healthcare. Developed countries usually have several such services, some of which operate worldwide. For example, Canada has more than 10 accreditation organizations, including Accreditation Canada, the Canadian Healthcare Council, Canadian Centre for Accreditation, CSA Group Testing & Certification, Bureau de normalization du Quebec and Lloyd's Register Quality Assurance.

Accreditation bodies in the healthcare arena can also seek international recognition from the International Society for Quality in Healthcare (ISQua), the principal international body on voluntary accreditation in healthcare. ISQua "accredits the accreditors" by issuing standards and surveillance in three areas: healthcare standards, external evaluation organizations, and surveyor training programmes. The evaluation of bodies and standards is based on private standards, and they do not comprise an assessment or accreditation by public authorities. The requirements and main procedures are described in the accompanying box.

⁶⁹ "Accreditation" in the healthcare context has a meaning that is different from that used in the traditional QI context. According to the International Society for Quality in Healthcare (ISQua) accreditation means "a public recognition by a healthcare accreditation body of the achievement of accreditation standards by a healthcare organization, demonstrated through an independent external peer assessment of that organization's level of performance in relation to the standards. Available at: <https://isqua.org/>

⁷⁰ Smits, H. Supachutikul, A. & Mate, K. (2014), "Hospital accreditation: lessons from low- and middle-income countries". Available at: <https://globalizationandhealth.biomedcentral.com/articles/10.1186/s12992-014-0065-9>

ACCREDITING THE ACCREDITORS

An organization, or part of the organization, which is a recognized external evaluation body, “accreditor”, within the health or social care sector is eligible for assessment and recognition by the International Society for Quality in Healthcare (ISQua). In other words, ISQua “accredits the accreditors”; a situation that is very specific to the healthcare sector.

The aim of the accreditor should be to improve the quality of care for the public by providing external evaluation services based on quality standards and related services that support performance improvement. The organization may address specific clinical or specialist areas or services.

ISQua must assess and award at least one set of standards, before an accreditor is surveyed for recognition. ISQua surveyors are internationally based in over 18 countries representing managers and auditors from senior positions within the health and social care external evaluation community. The survey team submits the final report to a validation panel with the award recommendation.

Source: ISQua

The path forward

Good health and well-being are fundamental objectives for all countries. For developing countries, they are even more important, being an essential component of the path to prosperity and the challenges these countries have to address.

ACCREDITATION IN WEST AFRICA

With UNIDO support, a West African Accreditation System (SOAC), covering eight ECOWAS member states was established. SOAC issued an accreditation certificate to the National Public Health Laboratory (LNSP) in Cote d'Ivoire 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 two 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.

QIs provide vital contributions to the achievement of SDG 3. Efforts to establish or strengthen national QI - including regional cooperation and services - should therefore be given adequate attention and priority by policy makers in these countries. The following strategic directions are recommended:

- » Quality infrastructures is essential to supporting effective and efficient healthcare services, for both inputs, including medical equipment, medicines, and processes, such as prevention, assessment, patient treatment, patient care
- » Investing in QI as it improves health outcomes, increases the efficiency of treatment and contributes to cost-effectiveness
- » Infrastructure for scientific research is also a valuable asset for any country wishing to stimulate local entrepreneurship and attract inward investment. There are multiple direct and indirect ways in which giving scientific infrastructure a prominent place in developing countries' national health plans and funding programmes could help promote better health outcomes. The development of a sound scientific infrastructure for health goes hand in hand with establishing or strengthening the QI
- » Development of a sound primary healthcare system is a paramount objective for most low-income countries and a pre-requisite to achieving universal healthcare coverage. Policies, allocation of resources and efforts should take this into account. Risk management and emergency preparedness for health should also be part of essential national priorities
- » Adoption and implementation of digital healthcare methodologies should be actively pursued, as a means to exploit their potential to expand access and improve the provision of healthcare services
- » Strong coordination among government agencies, QI institutions and other relevant actors is of paramount importance to effectively address public health threats such as food poisoning and antimicrobial resistance

5.3 Affordable and clean energy



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

SDG 7 is a global call to ensure access to affordable, reliable, sustainable and modern energy for all – with specific targets related to the profound transformation of the energy sector required to achieve it. Affordable and clean energy, especially electricity, has an impact on many other SDGs and the development of all nations and economies.



Energy and prosperity for all

Energy is indispensable for human activities. Modern societies born after the industrial revolution, with the ability to use fossil fuels, have been established on and require the use of an enormous amount of energy compared to previous eras of human history.

Industry, modern cities and transportation networks could not exist without an abundant energy supply. Modern life and the features 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 an energy supply.

A significant amount of energy is also indispensable for modern agriculture. Today, the agricultural output needed to feed the world population substantially depends on hydrocarbons. These provide the fuel currently used for tractors and all other machines used in agriculture and are also utilized in the production of fertilizers and pesticides.

It is therefore not surprising that global primary energy consumption⁷¹ has increased 25 times between 1800 and 2015, from less than 6.000 TWh per year to over 146.000 TWh per year.⁷² In recent times, energy consumption has continued to grow – at a rate close to 2 % per year since the year 2000 - and it is expected to continue growing at around 1 % annual rate until 2040 (according to the baseline scenarios of IEA and others).

However, 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.

To fully understand the terms of today's energy conundrum, we need to consider that on the one hand energy is indispensable to economies and societies but, on the other hand, the energy sector is responsible for a substantial share of greenhouse gas emissions, which together with other forms of pollution represent one of the most serious threats for humanity.

Energy challenges and transformation

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. There are four major challenges described below that need integrated action: energy demand;

CO₂ emissions from energy-related activities; access to clean cooking fuels and technologies; and access to electricity by everyone.

⁷¹According to physics, energy cannot be “created” (“produced”, etc.) or “consumed”: energy can only be transformed from one form to another. Commonly used terms such as energy “production” or “generation” actually mean transformation of energy in forms that are suitable for use by human activities, and “consumption” transformation to lower quality states, to a final disordered state of dissipated heat.

⁷²Vaclav Smil (2017) and BP Statistical Review of World Energy.

Energy demand

According to the International Energy Agency (IEA),⁷³ global energy demand is expected to grow steadily in the coming years, with a projected increase of more than 25 % by 2040 compared to 2017, which was used as the the baseline. 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 and continued investment. Complex decisions must be made aiming to support the development path of these countries while taking into account the environmental and social challenges related to increases in energy supply and use.

CO₂ emissions from energy-related activities

The IEA⁷⁴ states that the global energy-related CO₂ 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 by 2040. Given the current reliance on fossil fuels, the energy sector is responsible for about 75 % of the total CO₂ emissions. The trends outlined above are clearly incompatible with the 2° Celsius target for global temperature increases of the Paris Agreement, referred to under SDG 13.

Addressing this challenge will require bold and effective action. Decisions made today about new plants and facilities are critical because existing or planned power-generation plants, buildings and factories already account for over 20 Gt of the annual CO₂ 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.

Clean cooking fuels and technologies

According to the WHO,⁷⁵ around three billion people still cook using polluting open fires or simple stoves fueled by kerosene, biomass and coal. Each year, close to four 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.

⁷³IEA, “World Energy Outlook”, 2018.

⁷⁴Ibid.

⁷⁵WHO, “Fact Sheet: Household air pollution and health”, 2018.

The High-level Political Forum (HLPF) on Sustainable Development 2018⁷⁶ states that 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, according to the HLPF: “If current trends continue, 2.3 billion people will continue to use traditional cooking methods in 2030”.⁷⁷

Access to electricity for everyone

The HLPF also communicated: “From 2000 to 2016, the proportion of the global population with access to electricity increased by almost 10 %, 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”.⁷⁸ 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.

Exceptional efforts need to be pursued to address these challenges and to achieve SDG 7. Solving the energy conundrum is probably humanity's hardest challenge, along with climate change – in fact, the two are strongly inter-related.

Now, there are two main strategic directions required - a move to renewables and increased energy efficiency. It is imperative that countries rapidly change their energy generation capability from coal and other fossil fuels towards renewable sources including solar, wind, geothermal and the sustainable use of hydropower and biomass.⁷⁹ This is of existential importance to reduce CO₂ emissions. A transition to cleaner energy forms will also alleviate local air and water pollution and the accompanying harmful environmental and health impacts.

It is also important to realise that fossil fuel reserves are unevenly distributed geographically. In 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 these renewable fuels is rapidly decreasing. According to the International Renewable Energy Agency (IRENA): “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)”.⁸⁰

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. This fundamental techno-economic dynamic is often neglected, with business decisions based on past data and linear

⁷⁶Sustainable Development Goal indicators website, Available at: <https://unstats.un.org/sdgs/report/2018/goal-07/>

⁷⁷Ibid.

⁸⁰IRENA, “Global Energy Transformation: A Roadmap to 2050”, 2018.

projections. These are seriously misleading when variables evolve in non-linear, often exponential ways.

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: according to the IEA, since 2000, global energy efficiency gains have avoided a 12 % increase in energy use in 2017.

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 - power generation, buildings and households, industry and transport – and emphasizing that energy efficiency alone can already deliver substantial economic, environmental and social benefits.

The Efficient World Strategy (EWS) scenario developed by the IEA shows the huge potential impact of energy efficiency – if all already available energy efficiency measures were implemented between now and 2040. While global GDP could double by 2040, in the EWS scenario, energy efficiency would limit the increase in primary energy demand to levels only marginally higher than those of today.

The EWS would also result in lower emissions in 2040 compared with today: energy efficiency alone could provide more than 40 % of the reduction required by 2040 to be in line with the Paris Agreement.

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.

The role and results of QI

There are a variety of policy measures that governments can use to support and accelerate the energy transition. These include:

- » Regulatory and market-based instruments – from regulation setting targets, (e.g. percentage of renewable energy to be provided), or specifying limits on energy use and emissions
- » Fossil fuel taxes and tradeable permits
- » Economic and fiscal incentives
- » Contributions to research and development
- » Advocacy
- » Awareness raising and communication

The same applies to actions undertaken by governments, development agencies and the private sector to extend access to energy to everyone and to support the dissemination of clean cooking fuels and technologies.

QIs underpin or complement effective policies and programmes by which countries can implement the energy transition required to achieve SDG 7.

Renewable energy

Currently, the two leading technologies for renewable power generation 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:⁸¹ “Quality assurance (QA) has proven to be indispensable for establishing an enabling environment for a rapid uptake of renewable energy technologies”. It explains that QA 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. IRENA affirms. “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.”

DEVELOPING INTERNATIONAL STANDARDS FOR SMALL HYDROPOWER

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 Li 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.”

Wind energy

Global wind-power capacity has grown from 24 gigawatts (GW) in 2001 to 540 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.

⁸¹IRENA, “Quality Infrastructure for Renewable Energy Technologies – Guidelines for Policy Makers”, 2015.

Operational and 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 and implementation criteria to ensure the engineering integrity and protection against damage from all hazards during the planned lifetime. These standards are complemented by other IEC and ISO standards, along with a variety of national standards and regulations and certification schemes aiming to ensure the safety, reliability and quality of installations. Almost all large-scale wind turbine installations are certified according to schemes such as IEC 61400-22 or schemes provided by certification bodies or other authorities.

Solar photovoltaic (PV) energy

Global solar photovoltaic (PV) capacity has grown from less than five gigawatts (GW) in 2006 to 404 GW at the end of 2017, an average increase of about 50 % a year. An IRENA report⁸² published in 2017 notes that solar PV systems are now a very competitive power supply option and, with trillions of US dollars at stake, “more efforts should be made to ensure that these systems deliver as expected throughout their lifetime.”⁸³ In this respect, the same report states: “Quality assurance 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.

Over 100 international standards have been published to date by the International Electrotechnical Commission (IEC), through its technical committee TC 82. A significant part of them represent the core group of standards for PV technologies used on a global scale. These core standards are complemented by national standards, which address specific conditions or requirements linked to local regulations.

These standards cover every aspect of PV energy systems, from solar cells converting solar radiation into electricity, to the manufacturing of solar panels, to aggregating and operating large-scale PV systems, to the interface with the electrical system(s) to which energy is supplied.

The portfolio of PV standards is continuously growing, in parallel with the evolution of technologies, safety

⁸²IRENA, “Boosting Solar PV Markets: The Role of Quality Infrastructure”, 2017.

⁸³Ibid.

requirements, quality/reliability and electrical performance grading, and environmental aspects, e.g. electromagnetic pollution and disposal of hazardous substances.

A plurality of related QI services has been established at international and country levels: notably inspection and certification regarding safety/quality and performance aspects of the various components of equipment, and accreditation schemes aiming to ensure the competence of testing laboratories, or of conformity assessment providers for installation, operation and maintenance services.

Renewable energy is mostly generated on a smaller scale than traditional power stations, in many more locations, and is intermittent. Consequently, the distribution network must cope with energy flow both into and from the network. This requires careful measurement and control to avoid degradation to power quality and blackouts. Smart grids are highly complex, difficult to optimize and vulnerable to instability. This means that a paradigm shift is required in the instrumentation and control requirements to ensure quality and stability in electricity supply.

ACCREDITED CERTIFICATION OF JAPAN'S RENEWABLE ENERGY PRODUCTS

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. Accredited conformity assessment is specified as appropriate in state tender requirements to benefit from reduced pollution, energy costs, increased competition, and informed supplier selection.

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 sectors of energy use: transport; building and appliances, and industry. Energy efficiency can be driven 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. MEPS are also usually complemented by energy efficiency labelling, which is voluntary but can help consumers to make more informed buying decisions

- » Incentives to encourage the adoption of energy-efficient technologies and practices, including: grants and subsidies, tax relief, equity finance, loans and debt finance

Standards and QI services such as testing, inspection, certification and accreditation exist and are rapidly evolving in all the main energy use sectors (transport, building and appliances and industry) – but given the vastness and complexity of the subject it is not possible to cover all aspects in this publication.

What can be said in general terms is that the actual energy consumed is impacted by technologies, usage patterns and a variety of 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 underlines the importance of the arrival of energy management systems (EnMS).

These have now emerged as a best-practice approach for businesses to achieve energy efficiency gains. Furthermore, it has given rise to an international standard, ISO 50001, which organizations in all sectors and of any size can use to track and analyze energy use, and act on findings to improve energy efficiency, or make use of renewables.

ADOPTION OF ISO 50001 IN THE UAE

In the United Arab Emirates (UAE), the Sharjah Electricity and Water Authority (SEWA) is one of three government utilities that have now implemented an ISO 50001-based energy management system.

Within one year of implementing this standard they achieved an energy saving of just over 7%, equating to an energy cost saving of USD 26,000. Implementing ISO 50001 was one of SEWA's strategic initiatives for the fulfilment of its vision towards achieving energy conservation, maintaining load growth, and meeting sustainability and climate change objectives.

The standard is based on the same management system model of continual improvement used by ISO 9001 (quality management) and ISO 14001 (environmental management), giving organizations opportunities for integrating their management systems.

Industry-tailored guidance can greatly facilitate the 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.⁸⁴

⁸⁴ From UNIDO “Bridge Training document”, p. 3.

USING STANDARDS FOR ENERGY EFFICIENCY IN MEXICO

Mexico has implemented a policy, supported by energy efficiency (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.

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.

The path forward

Economic development and prosperity are strictly dependent on the availability of abundant and affordable energy. A large part of the world's population continues to lack access to electricity and to clean energy for primary needs such as cooking. At the same time, the energy sector is responsible for a substantial share of greenhouse gas emissions, one of the most serious threats to humanity.

The transformation needed to 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 the implementation of effective and efficient regulatory frameworks and market processes regarding energy transition.

Efforts to establish or strengthen national QIs should continue to be part of national and regional development priorities, which 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 the 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 a 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 such as buildings, industrial plants and various components of the transport system
- » Operation of existing structures
- » Production and expanded use of energy-efficient devices for lighting, heating, cooling and cooking

The adoption and implementation of standards, accreditation and conformity assessment schemes for buildings and industrial applications (e.g. electrical motors), for energy labelling of electrical appliances and other devices, should also be pursued as either voluntary or mandatory measures, depending on the context and local priorities.

Low income and some middle income countries need to dedicate significant efforts to meet the needs of people living in rural areas and shanty towns who lack access to electricity and to clean cooking fuels and technologies.

For financially secure communities, solar PV, off-grid or micro-grid solutions, combined with the use of affordable and efficient appliances and lighting devices, are now the preferred option. Use and mastering of standards for off-grid solar PV equipment, along with guidance for installers and local communities, are important tools to support the dissemination of these solutions.

For the poor, the production and broad dissemination of safe cooking devices making efficient use of fuels is a priority. Standards for measuring and comparing the performance of cook stoves against a set of internationally agreed sustainability indicators, have been developed in recent years by the ISO⁸⁵ with the support of the Clean Cooking Alliance.⁸⁶ These are used as a basis for testing, comparing and classifying products – aspects that will contribute to support investment and to the development of a sound clean cooking sector.

⁸⁵ More information from ISO Technical Committee 285, "Clean cookstoves and clean cooking solutions". Available at: <https://www.iso.org/committee/4857971.html>

⁸⁶ A public-private partnership with a global network of over 1,800 partners, working to increase global access to clean cookstoves and fuels. Available at: <https://www.cleancookingalliance.org/home/index.html>

5.4 Clean water and sanitation



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

SDG 6 is a call to action on basic human rights:

- » Universal access to safe and affordable water
- » Adequate and equitable sanitation and hygiene for all
- » Preservation and careful management of water resources to maintain their contribution to natural ecosystems and human economic activities

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 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, that QIs can make, need to ensure positive contributions to meeting these challenges and that they are coordinated and mutually supportive.

Clean water, sanitation and prosperity for all

The availability of water in large quantities and proximity to water ecosystems have been essential for the development of human civilizations. At the opposite end of the spectrum, severe water shortages, determined by prolonged droughts or by mismanagement of water resources, have been among the primary causes of the collapse of civilizations.⁸⁷

Water quality has also been considered essential since the dawn of time. The importance of pure drinking water was recognized in the early stages of civilization, because water contamination posed a serious health risk to sedentary populations living off agriculture, and even more to the urban concentrations that they created. Despite this, throughout history the organization of water supply and sanitation, wastewater management, and balancing the needs of cities and their agricultural surroundings throughout history has not been a linear process of improvement. For example, 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

⁸⁷ 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 droughts has been a primary factor.

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 (and more water intensive) diets. 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.

It is evident that preserving and carefully managing water resources is imperative for economic development. The jobs of some 1.4 billion people in food and beverage, extractive and water treatment industries depend directly on water, and the livelihood of hundreds of millions of smallholder farmers is based on water. UN Water notes: "Economic growth is still a priority for most countries. SDGs cannot be met without growth, which tends to overshadow other issues." But it warns: "Unsustainable borrowing from water and land resources will not help to meet these targets".⁸⁸

Clean water, challenges and transformation

Major trends such as population growth, urbanization, agricultural intensification, land use change, industrial development, transport and trade, all 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 leading both to more frequent and severe droughts and to an increase in land becoming transformed into desert.

This gives an idea of the global challenges that must be addressed. In their report *Making Every Drop Count: An Agenda for Water Action*, the High-Level Panel on Water (HLPW) notes: "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".⁸⁹

Access to safe and affordable water and to adequate and equitable sanitation and hygiene are considerable challenges. The lack of safe water, sanitation and hygiene services is a major risk factor for infectious diseases and mortality that disproportionately affects regions such as sub-Saharan Africa, and Central and Southern Asia.

⁸⁹ High Level Panel on Water (HLPW), *Making Every Drop Count: An Agenda for Water Action*, 2018.



A related challenge concerns water contamination and 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 other toxic substances)
- » Oil spills
- » Persisting organic pollutants (POPs)
- » Pesticides
- » Emerging threats include plastics and pharmaceuticals

Once contaminated, water may no longer be used for specific activities – including drinking and 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 USD four trillion between 2007 and 2011. An extensive challenge concerns the increase of contamination from industrial wastewater deriving from the shift of production from industrialized countries to emerging economies and developing countries. In many cases, the latter are not really prepared for the challenge and this is particularly important in the case of heavy-processing and high environmental-impact industries.

Another challenge is posed to water conservation. This applies to surface water in rivers and basins and most seriously to groundwater – the freshwater that is increasingly used to supplement 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 recent times, thanks to scientific and technological progress (geological knowledge, drilling, pumping, availability of energy) and surging demand, the use of groundwater has dramatically increased. Today, it represents over 35 % of the freshwater used in the world and this figure keeps growing fast.

Intensive groundwater abstraction disrupts the inflow and outflow equilibrium, resulting in progressive groundwater storage depletion. Global abstraction causes the permanent depletion of groundwater aquifers, estimated to be almost 200 km³ per annum, nearly one-fifth of all groundwater pumped.⁶⁰

Over-abstraction does not only diminish future supplies by depleting non-renewable aquifers and lowering water tables (which lead to increasing abstraction costs and/or putting existing wells out of business),

⁶⁰ FAO, “Groundwater Governance 2030: A call-for-action”, 2016.

but can also cause irreversible damage through land subsidence and salinization.

There is a growing consensus that such water-related challenges can only be met by adopting a more integrated approach to managing and allocating water resources. The concept of integrated water resources management (IWRM) is embedded in the 2030 Agenda.⁶¹ 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.

Responding to these and the other challenges already identified will require substantial, coordinated and focused international efforts that include the need to identify, develop and strengthen regional and national QI capabilities and capacities.

The role and results of QI

QIs give national and local regulatory authorities, public or private operators of water and wastewater services, industries, households and other stakeholders the technical means for effectively managing water resources. This means promoting water conservation, ensuring that water can reach more people, that it is fit for drinking and other end uses, and that water pollution is being controlled.

QI and access to safe water

The WHO Guidelines for Drinking Water Quality (GDWQ)⁶² provide a framework for operating safe drinking water systems. These include health-based targets to be set by national authorities, water safety plans 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.

Developed countries have introduced significant national or regional regulations addressing water quality. Examples include:

- » The European Drinking Water Directive (Council Directive 98/83/EC of 3 November 1998 and amendments including Commission Directive (EU) 2015/1787 of 6 October 2015), which concerns the quality of water intended for human consumption. Its objective is to protect human health from

⁶¹ 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.”

⁶² WHO, “Guidelines for Drinking-Water Quality”, 4th edition, 2017.

adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean

- » The US Safe Drinking Water Act (SDWA) of 1974, which is the principal federal law in the United States intended to ensure safe drinking water for the public. The act requires the Environmental Protection Agency (EPA) to set standards for drinking water quality and oversee all states, localities, and water suppliers that implement the standards

While there are significant differences, both regulations identify a list of organic and inorganic substances for which mandatory limits should be met, along with monitoring requirements, criteria and practices for quality surveillance. In these contexts, the WHO Guidelines are used as a scientific reference. Other organizations, such as the ISO, have issued complementary normative documents.

THE ISO'S STANDARDS FOR WATER QUALITY

The ISO has developed some 300 standards for water quality, including drinking water, focused primarily on characterization of water properties, of contaminants in water, related test methods and water efficiency management. National or sectoral standards are also used, often to provide technical complements to national regulations.

QIs and water infrastructure

To allow connection to water distribution networks by many who are currently deprived, numerous countries and especially developing ones need to improve existing physical infrastructure, or build anew. This includes extensions both to existing large, centralized systems and also to decentralized mechanisms for supplying water to distant, or small communities.

Developing countries must also invest in expanding wastewater networks, building and maintaining the infrastructure to collect and treat sewage.

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 water supply should perform and interconnect.

Countries can also experiment with local innovations, such as installing small-scale water delivery systems quickly and, once proven in use, employ the process of standardization to share these innovative applications with potential users worldwide.

QIs and water contamination

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

UK CODE OF PRACTICE FOR WATER POLLUTANTS

A United Kingdom 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 suitable standard tests 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 body, 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.

In developed countries, a comprehensive and complex set of national and regional regulations have been developed to address water pollution by a variety of sources, notably human and other urban waste, agricultural waste, and industrial waste. Examples are the USA Clean Water Act (CWA),⁹³ the federal law that regulates the discharge of pollutants into the nation's surface waters, including lakes, rivers, streams, wetlands, and coastal areas, and the EU Water Framework Directive (WFD).⁹⁴ The WFD was adopted to succeed and replace traditional water management practices aiming at controlling the emissions of individual pollutants monitored at the

⁹³ US Environmental Protection Agency (1972), "Summary of the Clean Water Act". Available at: <https://www.epa.gov/laws-regulations/summary-clean-water-act>

⁹⁴ European Commission (2019), "The EU Water Framework Directive – integrated river basin management for Europe". Available at: https://ec.europa.eu/environment/water/water-framework/index_en.html

point of discharge. Instead, the WFD introduces a systemic approach, integrating all aspects of the water environment, including both surface and groundwater, aiming at achieving a "good status" for all waters, and using "river basins" – the spatial catchment area of a river- as the basic geographical and hydrological unit.

Whilst standards for wastewater treatment exist mainly at national or regional level, some international references have been developed and their role will most likely increase in the future. Among them it is worth noting:

- » The *WHO Guidelines on Sanitation and Health*, 2018, which aim to promote safe sanitation systems and practices in order to promote health. They provide recommendations of good practice for safe sanitation services, and principles for implementation of interventions to improve sanitation and hygiene
- » Standards from the ISO Technical Committee ISO/TC 275, covering the methods for characterizing, categorizing, preparing, treating, recycling and managing sludge and products from urban wastewater collection systems

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 into

the aquatic and natural environment. These standards can facilitate the design of effluent charges and other regulatory instruments for pollution control.

QIs 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 indicates specific targets related to water conservation, calling for increased water-use efficiency, integrated water resources management, and the protection and restoration of water-related ecosystems.

A QI can make an important contribution to water conservation with a focus on efficiency. The QI building blocks of 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, such as irrigation, domestic use and drinking water, and industrial applications
- » **Water management:** Criteria and good practice for the use of water in a variety of contexts and the provision of water services by utilities, relating to drinking water, wastewater and storm water
- » **Water footprint assessment:** Methods and tools for assessing the "water footprint" of products

and activities - the volume of freshwater used to produce a product or to provide a service, measured over the complete supply chain

Another QI contribution to water conservation 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 by providing methods and tools to support all the operations involved in the: collection; processing; storage; distribution; consumption; drainage; and other handling of wastewater and treated effluent. A QI can therefore ensure compliance to the quality requirements for various purposes, from irrigation, to industrial use, as well as drinking water.

CONFORMITY ASSESSMENT SERVICES FOR WATER TESTING IN MALAWI

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 findings were that the MBS water testing laboratory is in compliance with most of the requirements of ISO/IEC 17025:2005 and is competent to test the safety of the bottled drinking water ensuring consumer safety.

The path forward

Access to safe water and sanitation are basic human rights. Use of freshwater is also vital to economic activities and to achieve healthy and satisfactory standards of living.

WATER AND ACCREDITATION

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.

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. This is even more so for countries that 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 at 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 by reducing strain on the healthcare system. Managing water sustainably requires governments to have reliable programmes for measuring and monitoring national water resource usage. Sources of pollution also need to be identified and monitored using suitable metrics. These activities require metrological, analytical and testing 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. Partnerships and collaboration with regional and international organizations, and support by development agencies are potential sources of solutions.

5.5 Gender equality



SDG 5 – Achieve gender equality and empower all women and girls

SDG 5 calls for gender equality by ending all forms of discrimination, violence and any harmful practices against women and girls in the public and private spheres. Gender equality is a goal in its own right, but it is also vital to the achievement of other development goals such as poverty reduction, economic growth and environmental sustainability. It is the essential building block for a more equitable and productive society.

Gender equality means creating equal opportunities for women and men by allowing them to contribute on equal terms economically, politically, socially, culturally and in decision-making and leadership. It means that no one will be prevented from reaching his or her full potential because of their sex, and puts equal value on the varying roles played by women and men in society. Gender equality is also widely acknowledged as a prerequisite for sustainable development in its three dimensions – economic, social and environmental.

Gender equality and prosperity for all

Gender equality is a fundamental human right, and is a necessary foundation for a prosperous, sustainable and peaceful world. It is proven that empowering women and girls helps economic growth and development.⁹⁵ Gender-sensitive and responsive activities are core objectives of the 2030 Agenda for Sustainable Development. Gender equality is not just an opportunity in its own right but also a major contributor to ending hunger, combatting inequalities, peace-building, promoting and protecting human rights, and ensuring the lasting protection of the planet and its natural resources.⁹⁶ Ensuring a comprehensive approach to SDG 5, which leverages synergies between SDG 5 and other SDGs, will contribute to realizing gender-targeted development outcomes in implementing the 2030 Agenda. Realizing gender equality and the empowerment of women and girls will also make a crucial contribution to ensuring progress across all goals and targets.

Gender equality challenges and transformation

a) Gender equality and trade

Trade activities have different effects on women and men who have diverse economic and social roles and varying access to and control over resources.⁹⁷ Women tend to be more affected by the negative impacts of trade liberalization and face bigger challenges than men when it comes to taking advantage of the opportunities that trade offers.

This situation arises out of gender biases in education and training, gender inequalities in income and command over resources, as well as unequal access to productive inputs such as credit, land and technology. These biases and inequalities have a distinct link to tradition and culture at large as gender roles can effectively be considered as being determined by culture, with tangible effects on the power relations between men and women and access to economic opportunities, such as jobs.

Gender inequalities determine the differential impact of trade on women and men. This can happen at the sector, government and household levels.⁹⁸ At the sector level, trade can increase or reduce employment and income opportunities for women, depending on

⁹⁵UNDP (2019), “Goal 5: Gender Equality”. Available at: <https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-5-gender-equality.html>

⁹⁶Wahlen, C.B. (2017). “Achieve Gender Equality to Deliver the SDGs”. Available at: <http://sdg.iisd.org/commentary/policy-briefs/achieve-gender-equality-to-deliver-the-sdgs/>

⁹⁷ UNIDO (2015), “Guide on Gender Mainstreaming Trade Capacity-Building Projects”. Available at: https://www.unido.org/sites/default/files/2015-02/Gender_TCB_Guide_o.pdf

⁹⁸Ibid



whether the sectors where women work expand or contract as a consequence of trade liberalization and import competition.

At the government level, fiscal revenue and public expenditure – influenced by changes in tariff earnings due to trade liberalization – have an impact on public investment in social infrastructure and services that particularly benefit women, such as health, education, electricity, water, sanitation and other infrastructure to meet household needs.

At the household level, expenditure may decrease or expand according to the effects of trade on prices of consumer goods.⁹⁹

Although a number of women are involved in trade-related services, their contribution goes unrecognized. Informal cross-border trade is a major economic activity in a number of regions across the globe, particularly in sub-Saharan Africa where the majority of small traders and carriers are women. Women play a critical role in food security, carrying basic food products from their production point over the border to areas where they are in short supply. Yet they often have to suffer severe delays and even losses at border controls due to ill-treatment, and abuse from government officials – who are mostly men. A lack of information on their rights and also the lack of visibility, underpinned by cultural beliefs, contribute to perpetuate a highly discriminatory and detrimental situation.¹⁰⁰

b) Standardization process

Standards are generally presumed to be gender-neutral, and are commonly developed without recognizing the differences between male and female consumers. However, in the design of standards there is often a failure to explicitly analyze the needs of different genders, and this contributes to strengthening rather than fighting gender inequality.

Gender equality concerns are not taken into consideration in the standardization process, which can potentially result in the development of standards that perpetuate gender discrimination. The share of women involved in standard-setting activities is low – according to the United Nations Economic Commission for Europe (UNECE), it is about 10 %. There are also no tools allowing for the analysis of existing standards through a gender lens.¹⁰¹

⁹⁹ Ibid

¹⁰⁰ Ibid

¹⁰¹ Jachia, L. (2018), “Standards & Gender Equality”, UNECE. Available at: https://www.unece.org/fileadmin/DAM/trade/wp6/documents/2018/PPTs/1511_am_Lorenza_Jachia_Gender-Responsive_Standards.pdf and UNECE (2019), Gender Responsive Standards, United Nations, New York & Geneva. Available from: https://www.unece.org/fileadmin/DAM/trade/Publications/ECE_TRADE_445E.pdf

UNECE GENDER RESPONSIVE STANDARDS INITIATIVE

The UNECE Gender Responsive Standards Initiative aims to provide a framework through which standards bodies are able to make the standards they develop, and the standards development process they follow, gender responsive. Established in 2016, the initiative has the objectives of (i) strengthening the use of standards and technical regulations as powerful tools to attain SDG 5 (Achieve gender equality and empower all women and girls); (ii) integrating a gender lens in the development of both standards and technical regulations; and (iii) elaborating gender indicators and criteria that could be used in standards development.

Empowering and promoting the greater inclusion of a gender lens in standardization and regulatory policy will create sustained and inclusive economic growth, necessary to reduce inequalities. Moreover, gender responsive standards will help to ensure safe and secure working environments for all workers.

The role and results of QI

QI development may potentially have positive impacts on gender equality and the economic empowerment of women. Gender is a cross-cutting theme, which needs to be considered at all levels of QI development: quality-related policies and legislation; QI institutions as well as conformity assessment bodies and enterprises and/or producers participating in a global value chain.¹⁰²

Quality infrastructure, particularly standardization and standards, have implications for men and women. They have a potentially key role in driving gender equality. However, standards and technical regulations do not take gender considerations sufficiently into account, as previously mentioned. Standards-setting and development needs to consider social, physical and biological differences. By not doing so, individuals are put at risk or danger.

For example, the test methods for standards developed for the automotive sector included crash trials using dummies that anatomically resemble males, neglecting the particularities of average and pregnant females who do not properly fit car seatbelts, potentially leading to fetal death, related to maternal trauma in motor vehicle crashes.

Similarly, standards for air-conditioning settings in offices are based on the resting metabolic rate of a 40 year-old male, overestimating the metabolic rate of females on average by 20 to 30 %. Addressing gender

¹⁰² Kellerman, M. & Keller, D. (2015), “Leveraging the Impact of Business Environment Reform: The Contribution of Quality Infrastructure. Lessons from Practice”. Working Paper, Donor Committee on Enterprise Development. Available at: http://www.businessenvironment.org/dyn/be/docs/284/QIBestPractices_WorkingPaper_updated2015.pdf

factors while drafting air-conditioning standards would not only make all office workers more comfortable, but would also lead to energy savings and lower emissions.¹⁰³

The path forward

Placing gender in the mainsteam of the project cycle in quality infrastructure-related projects can promote gender equality. It goes beyond simply having a specific “women’s component” in a programme or project. In practice, all stakeholders and partners, both women and men, must be involved if the issue at hand is to be tackled effectively and efficiently. This approach recognizes the need to use participatory methodologies – which include both women and men – in order to address gender inequality and to promote the advancement of women. As a consequence, gender mainstreaming is a process that should be embedded throughout all stages of the project cycle.¹⁰⁴

Equal opportunities for women to participate in and benefit from trade capacity-building and technical activities, attain higher-level posts and the ability to contribute to decision-making processes will create the basis for a more equal society. It is crucial that women are given the same opportunities to contribute to the decision-making processes and to take on leadership roles in promoting quality and standards.

For example, this involves ensuring the balanced representation of women and men in technical committees. It will generate new needs and encourage the development of fresh, gender-responsive products. Therefore, equal access for women to resources and training opportunities should be promoted. This includes the creation of opportunities for skills development for women and girls, facilitating their access to employment and rewarding them for work well done in equal measure to men.

Quality infrastructure-related policy and the legislative and regulatory environment must not be conducive to discrimination against women, and women should have the right to participate in developing them. This involves systematically reviewing and evening out the impact of QI-related policy and technical regulations. It also requires promoting the safe and non-discriminatory delivery of national QI-related services which are favorable to trade development. Gender impact assessment could be used to prevent the perpetuation of inequalities through policy and regulations.

Voluntary sustainability standards (VSS) may potentially be leveraged to make positive contributions to gender equality as they may promote it depending on certain conditions. However, it is important to note that VSS can also exacerbate gender inequalities if

¹⁰³ APEC (2018), “The Role of Standards for Driving Gender Equality”. APEC Project Database. Available at: <https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2230>

¹⁰⁴ UNIDO, 2015.

they are not applied with sensitivity to local gender dynamics.¹⁰⁵

PROMOTING GENDER EQUALITY IN ZAMBIA

The main objective of the project (2009-2017) was to enhance the export performance of Zambia by supporting the re-engineering of its National Quality Infrastructure. The project has also significantly contributed to Zambia’s efforts in relation to gender mainstreaming and creating equal opportunities.

Since its inception in 2003, the Zambia Weights and Measures Agency (ZWMA) had no female employees in the management and operations department, however, in 2011; two female technical employees were engaged and one female management staff. The ratios were roughly 30 % female and 70 % male. The project monitored training statistics and encouraged organizations to include female candidates especially in the application procedure for technical trainings.

Furthermore, to assist the overall gender mainstreaming effort, a workshop was organized at the beginning of Phase 2 in cooperation with the Ministry of Gender to raise awareness of stakeholders and facilitate the development of gender mainstreaming guidelines for national quality institutions. A gender assessment was conducted for the Ministry of Commerce, Trade and Industry (MCTI) and other selected bodies including the Citizen’s Economic Empowerment Commission (CEEC), the Zambia Bureau of Standards (ZABS), the Zambia Development Agency (ZDA) and ZWMA.

The gender assessment captured specific expectations as well as concerns for gender mainstreaming since it identified areas of gender inequality present in each of the aforementioned bodies. The assessment proposed sustainable and impactful solutions to the areas of concern found, providing a good basis for the development of best practices in gender mainstreaming throughout the project cycle and beyond.

Standards being developed should be screened for their potential gender equality impact and specific standards with high potential for women’s empowerment should be prioritized. Gender should be mainstreamed into standards and the use of gender impact assessments should be promoted throughout the process of standardization, in order to develop standards that adequately reflect gender differences.

¹⁰⁵ Sexsmith, K. (2019), “Leveraging Voluntary Sustainability Standards for Gender Equality and Women’s Empowerment in Agriculture. A Guide Based on the Sustainable Development Goals for Development Organizations”. Winnipeg, Canada: International Institute for Sustainable Development (IISD). Available at: <https://www.iisd.org/sites/default/files/publications/vss-gender-equality-agriculture-en.pdf>

EMPOWERING FEMALE SEAWEED FARMERS IN INDONESIA'S PANGASIU VALUE CHAIN

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 the quality and yield of their products and enhancing the productivity and 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.

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.

In addition, there should be equal representation in standardization, to strengthen the participation of women in the development of international standards, to make standards responsive to women's needs globally.¹⁰⁶

Particularly relevant to sustainability and social responsibility standards, such as ISO 26000, Guidance on Social Responsibility, the inclusion of gender indicators or criteria at the preliminary or drafting stages ensures that gender considerations are an integral part of the standard.

As countries expand and strengthen their quality infrastructure through technical assistance or capacity-building activities, the increasingly strong presence of women at all levels, in both technical and managerial positions in quality-related institutions, should be strongly considered. It should also serve as best practice for other and future quality infrastructure-related projects.

¹⁰⁶ISO (2018), "Annual Report 2018". Available at: https://www.iso.org/files/live/sites/isoorg/files/about_per_cent20ISO/annual_reports/en/annual_report_2018_en.pdf





6. PROTECTING THE PLANET

In the context of the SDGs, the “planet” dimension tackles, for example:

- » Protection from environmental degradation
- » Sustainable consumption and production
- » Sustainably managing natural resources
- » Taking urgent action on climate change.

These actions will ensure that the planet can support the needs of present and future generations.¹⁰⁷

6.1 Climate action



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

SDG 13 has a central, connecting role within the framework of the SDGs. It calls for broad international cooperation to:

- » Build resilience and capacity to adapt to the adverse effects of climate change
- » Integrate climate change measures into national policies, strategies and planning
- » Improve education, awareness-raising and human and institutional capacity on climate change issues
- » Promote and mobilize resources in developing countries and promote mechanisms for effective climate change planning and management

Climate change has a substantial impact on the achievement of many other SDGs. Climate change mitigation and adaptation depend on how economic activities can be transformed to become “climate friendly”, or “carbon neutral”. This SDG is therefore relevant to energy generation and use, infrastructures, industry, agriculture, services and to conservation activities – such as the use of land and water, and the protection of biodiversity.

The issue of carbon neutral solutions is addressed in other chapters of this publication - on industry, energy and agriculture. The attention here is on the main contributions that QI can make to understand and monitor climate change, evaluate the impact of human activities on it, and assess the potential impact of changes.

¹⁰⁷ SUN (2015).

Climate change and prosperity for all

Increases in global temperature are expected to result in rising sea levels, increases of extreme and unpredictable weather events - such as record droughts 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 ecosystems.

Without adequate mitigation, climate change will impact the life of billions of people by making water more scarce and amplifying the pressure on agriculture and food production. It is also going to disrupt economic development, with a disproportionate impact on the most vulnerable countries due to the increased frequency of extreme weather that triggers 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 consensus¹⁰⁸ on the causes of climate change, primarily attributed to greenhouse gas (GHG) emissions. These are generated by human activity,¹⁰⁹ such as burning fossil fuels to generate energy, and to using energy for transport, industrial activities, buildings and households.

Jeffrey Sachs, one of the leading world experts on sustainable development,¹¹⁰ states: “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”.¹¹¹ 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 meaningful, effective measures. He underlines: “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.”¹¹²

Climate challenges and transformation

Climate science has clearly indicated that in order to avoid the worst consequences of climate change, we should limit the increase of global temperatures below

¹⁰⁸ See IPCC (2014) “Climate Change 2014 Synthesis Report”, IPCC Geneva.

¹⁰⁹ See articles referred to, Available at: <https://earthobservatory.nasa.gov/Features/CarbonCycle> and <http://www.bgs.ac.uk/discoveringGeology/climateChange/general/carbonStory.html>

¹¹⁰ 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.

¹¹¹ “The Age of Sustainable Development”, Columbia University Press, 2015.

¹¹² Ibid.

2° Celsius, making a best effort to stay within 1.5° C of pre-industrial levels. This was adopted as the primary goal of the historic Paris Agreement, reached at the 21st Conference of the Parties of the UNFCCC (COP 21), in 2015.

In order to strengthen the global response to the threat of climate change, Article 4, paragraph 2 of the agreement requires each party country to prepare, communicate and maintain successive nationally determined contributions.¹¹³

Collectively, three post-2015 agendas for action provide the foundation for sustainable, low-carbon and resilient development in a changing climate: the Paris Agreement, the 2030 Agenda for Sustainable Development, and the Sendai Framework for Disaster Risk Reduction.¹¹⁴

Not exceeding the temperature limit of the Paris Agreement is vital to the achievement of all three 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 effective QI are outlined in the following two sections. It is important to emphasize that the actions described should be considered and implemented within the framework of many of the other SDGs.

a) Mitigating climate change

Actions that mitigate climate change include the following:

- » **Vigorous 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 energy generation from renewable sources:** These may include solar, wind, hydroelectric, geothermal and biofuels. With the improvement in performance and reduction of the cost of renewable energy sources, many of them are already highly competitive in terms of current market prices
- » **Fuel transition:** The increasing transition to electric motors, use of electrical appliances and other devices to replace existing use of fossil fuels in internal combustion engines, industrial furnaces and gas appliances should be actively pursued together with the development of suitable infrastructure supported by low-carbon energy sources
- » **Carbon neutral land-use, land-use change,**

¹¹³ Details about NDCs. Available at: <https://unfccc.int/process/the-paris-agreement/nationally-determined-contributions/ndc-registry>

¹¹⁴ “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).

and forestry: The first priority is preserving existing forests and applying sustainable forest management. Other priorities include careful land-use planning, which entails limiting urban developments, the appropriation of natural habitats by industrial, commercial or agricultural activities, and exploitation of natural resources, as well as a transition towards sustainable agriculture

- » **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
- » **Responsible measures to limit population growth.** This is of fundamental importance, especially for those countries in which rapid population growth is occurring alongside significant economic growth. This combination can potentially disrupt the careful use of resources and increase the ecological footprint, including GHG emissions

b) Adapting to climate change

- » **Emergency preparedness:** Including planned responses to extreme climate events, for example floods, hurricanes and wildfires
- » **Agriculture and food production:** Some major issues concern the use of crops more resilient to droughts, soil protection, supporting tree species less vulnerable to storms and fires – and abandoning land at risk of flooding
- » **Urban planning:** Climate change should be considered a key element of future city planning, leading to more climate resilient cities, for example, by adapting building codes to the emerging climatic conditions
- » **Infrastructures:** Including climate change as a key element of current and future infrastructure development, such as avoiding critical hubs in areas at risk, or considering alternative routes for essential services

The role and results of QI

The actions outlined above should be supported by public policies such as carbon pricing, financing for low carbon development projects, incentives to promote low-carbon solutions, and by public-private partnership mechanisms. These include mandatory regulations and associated compliance monitoring mechanisms to be introduced and enforced in critical areas, such as carbon emissions. Voluntary standardization should also be supported and promoted by public authorities.

This means that the various components of the QI significantly support the development and dissemination of low-carbon solutions, as outlined in previous chapters. Here, attention is focused on

how QIs contribute to understanding and monitoring climate change, and to evaluating the impact on it of human activities.

Measuring climate-related variables is of fundamental importance in order to understand and monitor climate change. Most activities of data gathering and monitoring are performed by the World Meteorological Organization (WMO), its national members and a variety of partner organizations involved in the Global Observing System (GOS), in the Global Climate Observing System (GCOS) and the international collaborative system working on the Earth’s climate.

The need for scientific observations of ever-increasing complexity and accuracy is placing stringent demands for the precision and traceability of measurement results to internationally agreed units. Among the issues currently being addressed are:

- » Standardized criteria for the design of climatological networks and of stations within networks and good practice for the operation of climatological stations and networks
- » 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

Important emerging issues also being tackled include:

- » Standards and comparisons for atmospheric composition to ensure the long-term stability and reproducibility of reference materials, and explicitly defined calibration scales and their traceability according to the International System of Units (SI)
- » 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 gases with low uncertainty.
- » 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 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 (CI-MO). Complementing the work of WMO’s CI-MO there is increasing cooperation

ROLE OF STANDARDS AND CERTIFICATION

At the 21st session of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) 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.

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.

Measurement and assessment of GHG emissions from human activities are the other major direct contributions of QI to climate action. The basic contexts to be considered are:

- » GHG emissions and removal at country level
- » GHG emissions and removal by individual organizations and sectors
- » GHG emissions and removal by projects

Aggregation of data from individual organizations to economic sectors and sub-sectors are required to calculate emissions at country level. Other levels of aggregation are also needed for specific purposes, for example to evaluate the emissions from projects, metropolitan areas, other geographical areas or systems.

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 achieving the Paris Agreement goals and requires the 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

Emissions data for projects are also important, especially in relation to:

- » Initial and ongoing financing for climate action
- » Issuing 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 reduction, and an inability to track progress in emission reductions over time - all of which have an impact on trust. As such, information has become more and more vital to investors for managing risk, or making operational improvements. GHG emissions validation and verification have played a decisive role in ensuring that systems are sound and data are accurate.

Other roles for QI organizations include:

- » Development and dissemination of standards, particularly international ones, increasingly used as a reference for methods and processes aiming at detecting and quantifying GHGs, examples are ISO 12039:2001,¹¹⁵ ISO 14064 and ISO 14065¹¹⁶
- » Accreditation of laboratories and other conformity assessment bodies involved in measuring GHG, undertaking audits of organizations, or projecting GHG emissions

ACCREDITATION AS A REQUIREMENT FOR ENVIRONMENTAL SERVICES IN JORDAN

The Government of Jordan issued a decree 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.

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

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

¹¹⁵ ISO 12039:2001 Stationary source emissions – “Determination of carbon monoxide, carbon dioxide and oxygen - Performance characteristics and calibration of an automated measuring method”.
¹¹⁶ ISO 14064 and ISO 14065 provide an internationally agreed framework for measuring GHG emissions, verifying claims and accrediting the bodies that carry out such activities to ensure accuracy and completeness. They provide clarity and consistency between those reporting GHG emissions and their stakeholders.

- » Foster the development and broad dissemination of new technologies and products to improve the quality of products and enhance the confidence of customers. Examples are the renewable energy solutions essential to support the transition to a low-carbon economy – by establishing performance requirements, quality control and assurance practices
- » Develop improved frameworks and introduce incentives to promote low-carbon activities. This entails the rigorous assessment of GHG emissions for different types of activity that support policy makers and business leaders in designing and implementing national strategies for green growth and related economic development, including green procurement

The path forward

Developing capability in understanding, measuring and monitoring climate change is vital to achieving the SDGs, especially SDG 13.

All countries are exposed to climate crises such as droughts, water scarcity, floods, hurricanes and rising sea levels. They have a paramount interest in improving their ability to forecast and monitor weather events ranging from the ordinary, such as modified rain patterns, to the extreme, such as the frequency and intensity of hurricanes.

This requires strong and well-functioning QI institutions and capabilities to support, on the one hand, acquisition and management of meteorological and climate data, and on the other hand, the measurement of carbon emissions. The latter requirement covers both emissions from existing activities, as well as the data required for reliable forecasts for development projects. This is critical for assessing the true value of economic activities and development.

The ability to measure carbon emissions accurately and forecast them reliably is also an essential component of well defined and trusted project submissions for 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.¹¹⁷ Whilst the resources available today are currently below that envisaged by the Paris Agreement, it is expected that they will grow significantly in time.

¹¹⁷ 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 – GCF and GEF – as well as the SCCF and the LDCF shall serve the Paris Agreement.

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 when requesting climate funding. The same considerations apply for carbon offsetting projects.

Carbon offsetting projects are likely to increase in number and value due several factors: the planned new phase of the Emissions Trading System (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. A 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 is about “promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all”.

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 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 better a 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 – from consumption of raw materials and energy to pollution.

This transformation must be supported by a “rebooted” QI that provides internationally harmonized and agreed guidance for sustainable products and production processes, trusted measurement traceability, as well as test and inspection data together with reliable monitoring and conformity assessment processes.

Sustainable consumption, production and prosperity for all

The current abundance of products and vastly increased choice for consumers have contributed to human well-being. However, the way in which this has been achieved is the main cause of the considerable challenges that the world is facing today.

So far, economic development has been strongly correlated with the use of materials. In 1900, the world

consumed seven 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.¹¹⁸ The most important trends¹¹⁹ 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. North America and Europe have decreased their domestic material consumption (DMC)¹²⁰ but substantially increased the proportion of raw material equivalents of trade flows, that means the amount of primary raw materials required along the supply chain to produce the commodities that they import.
- » A decline in material productivity (that is economic output per unit of materials) after the year 2000.¹²¹
- » A substantial increase of waste as two billion tonnes of municipal solid waste are produced annually,¹²² along with seven 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 growing populations and urbanization in emerging and developing economies.

Consumer spending reached a staggering 64 % of global GDP in 2017¹²³ and a significant part of the GDP investment component is directed to further increasing 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,

¹¹⁸ UNEP and IRP data and reports.

¹¹⁹ Detailed information can be found in the IRP-UNEP 2017 report “Assessing global resource use: A systems approach to resource efficiency and pollution reduction.”

¹²⁰ 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”.

¹²¹ 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.

¹²² Global Waste Management Outlook, 2015.

¹²³ Estimate of TheGlobalEconomy.com, based on World Bank data.

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. Notable consequences include:

- » Continual increase of greenhouse gas emissions and of global temperatures
- » Reduction of the environment's ability to absorb carbon due, in particular, to deforestation and acidification of the ocean
- » Significant land and soil degradation leading to a reduced land base available for food production
- » Substantial loss of biodiversity, which translates into a drastic reduction of the biosphere's resilience
- » Increased pollution of cities and habitats such as the 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 – that certainly requires difficult choices and bold actions – is that it has the potential to create enormous economic opportunities. New businesses will be required and many benefits, including the creation of new jobs, can be expected to accrue. This is especially the case for those countries and organizations that seize the opportunity and create new “climate conscious” businesses and jobs on a large scale.

Production and consumption challenges and transformation

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

1. Extraction and use of materials as a primary input to the world economy
2. How products and services are used and disposed of
3. Use of hazardous substances in products and production processes
4. Capacity of the environment – air, water and land – to absorb waste and to cope with the other impacts of human activities

They can be 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 living conditions.

Regarding the first topic, the issue is not so much related to the physical availability of resources. While there are important exceptions, most materials are still relatively abundant. The challenging issues concern the scale of 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 the extraction of materials. A clear example of this is hydrocarbons.

The complexity, cost and energy return¹²⁴ of oil and gas extracted from ultra-deep-water, tar sands and fracking, compared to “traditional” extraction, show huge and increasing gaps. These disparities can only be maintained because of market dynamics and policies, such as subsidies and the transfer of substantial negative externalities to taxpayers, that help to maintain relatively low prices. Similar trends are evident for many essential metals.¹²⁵ 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 publication¹²⁶ 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 SDG 12 on responsible production and consumption, and also on almost all of the goals in a direct or indirect manner.”

CLEAN PRODUCTION

The objective of the UNIDO's 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 to the development and implementation of such initiatives.

This requires decoupling economic growth from resource consumption and environmental impact. Such decoupling could be achieved by:

- » Reducing the amount of materials and energy used in economic activities and reducing emissions and waste from extraction, production, consumption and disposal
- » Promoting a shift of consumption towards goods and services that require less energy and smaller amounts of materials, without compromising the quality of life

¹²⁴ Energy returned on energy invested (EROEI or EROEI); or energy return on investment (EROI).

¹²⁵ See e.g. Ugo Bardi, *Extracted* (2015)

¹²⁶ “Assessing global resource use: A systems approach to resource efficiency and pollution reduction”, IRP-UNEP, 2017.



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 cost-savings derived from increased productivity, the reduction of material inputs and wastage. In addition, using resources more efficiently can often improve corporate performance and competitiveness, helping to deliver more value to customers and increasing consumer satisfaction.

The first fundamental strategic direction, especially for developing and emerging economies, concerns essential infrastructure, including energy, buildings, transportation, water supply, sanitation, waste management, and food supply. Decisions have to be taken now. If countries choose low-carbon, resource-efficient energy and material, and pollution-free solutions, these can be phenomenal contributors to human well-being, by improving the quality of life and preserving the environment – as well as ensuring the future of the Earth.

A second 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.”¹²⁷

As highlighted by Braungart and McDonough,¹²⁸ 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” – the domain of the structures and artefacts created by human activities – can be organized in a similar way.

This can be done by creating “technical-nutrients” – raw materials and product components – to make goods and structures that last and do their job over extended periods of time, in contrast to the “planned obsolescence” which infuriates many consumers today. When they have reached the end of their useful life, they are used to build other products, even of different types to the original. This process can continue through several cycles. At the very end, the product components and materials are recycled to an extent that should ensure they can be harmlessly absorbed by the biosphere.

¹²⁷ The Ellen MacArthur Foundation. Available at: <https://www.ellenmacarthurfoundation.org/>

¹²⁸ Braungart M and McDonough W, “Cradle to Cradle”, 2002.

This requires a deep rethinking of economic activities, the promotion of innovation aimed at designing a new generation of products and systems - and along with that, fresh business models.

NEW ISO TECHNICAL COMMITTEE FOR THE CIRCULAR ECONOMY

The linear model of producing, using and discarding is causing the planet’s resources to be depleted. The solution to this is a “circular economy”, where nothing is wasted, but rather is re-used or transformed. While there are standards for components of this, such as recycling, currently no global vision has been agreed upon on how to complete the circle. A new ISO technical committee (TC) for the circular economy has recently been formed for this purpose.

ISO/TC 323, *Circular Economy*, is made up of 58 participating members and 12 observing members. It intends to produce a set of internationally agreed principles, terminology, and a framework of what a circular economy is, and develop a management system standard. It will also work on alternative business models and methods for measuring and assessing circularity.

The aim of this TC is to cover all aspects of a circular economy including public procurement, production and distribution, and end of life, as well as wider areas such as behavioural change in society, and assessment, i.e. some kind of circularity footprint or index.

The third fundamental strategic direction concerns consumers and consumption patterns. Consumerism is understood here as the availability of ever more consumer goods at affordable prices, to be used for a fraction of time and then thrown away. This has become the global model for prosperity. It is driven partly by human instinct and impulses, but enormously amplified by the marketing and communication efforts of business. It is possible – and imperative – to change all this.

On the one hand, information plays a fundamental role. Consumers need clear, concise and accurate information about the characteristics and impacts of the products and services they choose - including health, environmental and social aspects.

On the other hand, enterprises and policy makers have the responsibility to design, promote and implement new business models consistent with the paramount objectives of resource efficiency, elimination of waste and prevention of the “re-bound effect”, where efficiency gains are nullified by the resulting increases in consumption.

The role and results of QI

Accurate information is the foundation of 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 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 for determining the resource efficiency of products and systems.

A method that supports many of the solutions required is the life-cycle assessment (LCA), which helps to evaluate the environmental impacts of a product or service through all the stages of its life-cycle. LCA is to a significant extent a standardized methodology, defined by standards such as ISO 14040 and ISO 14044. Adopting a life-cycle perspective is a very useful means to discover at what stage of the cycle a product is causing the largest environmental burden, to quantify it, and then modify it to reduce its negative impact.

These instruments are also important in the support of public policies. Examples include:

» **Technical regulations** covering maximum pollution or emissions for given substances, restrictions of the use of particular substances or quantity of materials, mandatory use of equipment, type and quantity of waste. 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.

» **Economic mechanisms and incentives** such as pollution taxes, use charges or cap and trade mechanisms as well as subsidies – including direct contributions and tax breaks – for using desirable technologies or processes. The mechanisms also include green procurement, which means giving preference in public procurement to products and services that are deemed to be eco-friendly or sustainable. Here standards and conformity assessment procedures help by providing objective means to define and assess

the ecological performance of products and, in a number of cases, social impacts along the value chain.

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

ENERGY MANAGEMENT IN UKRAINE’S INDUSTRIAL SECTOR

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 System Standard ISO 50001.

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.

An important development is the quality improvement of “secondary raw materials” – materials recovered at end-of-use cycles that are suitable for recycling. These require standards for defining their characteristics and properties, along with 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 certification (ETV) programmes. The objective of an ETV programme is a reliable and independent verification of the performance of environmental technologies - this means 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 14034¹²⁹, ISO/IEC 17025¹³⁰ and ISO/IEC 17020¹³¹ prove useful in this regard.

¹²⁹ ISO/IEC 14034:2016 Environmental management -- Environmental technology verification (ETV).

¹³⁰ ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.

¹³¹ ISO/IEC 17020:2012, Conformity assessment — Requirements for the operation of various types of bodies performing inspection.



The path forward

National QI organizations, and their regional and international collaboration networks, are ideally positioned to support the transformation of the production and consumption patterns required to achieve SDG 12. However, they also need to re-focus and expand the scope of their activities to be fully aligned to the SDGs.

Policy makers should give priority to establishing or strengthening the national QI-related metrology, standards, accreditation, testing, inspection and certification mechanisms. It is also important to note that eligible countries can also be supported in this effort by international organizations, such as UNIDO. Attention should be concentrated on the following strategic directions, especially by developing and emerging economies:

- » Choices need to be taken now regarding essential infrastructure such as energy, buildings, transportation, water supply, sanitation, waste management and food supply. Planning and implementation should be based on long-term perspectives, considering critical factors such as the conservation of resources, 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 to products, the re-use of products and product components, the recycling of materials and the minimization, treatment and responsible disposal of waste, especially toxic waste. Governments, business leaders, responsible 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.

6.3 Life on land and life below water

14 LIFE BELOW WATER 	SDG 14 – Conserve and sustainably use the oceans, seas and marine resources for sustainable development and
15 LIFE ON LAND 	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 calls for the: sustainable management of marine and coastal ecosystems; prevention and reduction of all kinds of pollution; minimization of ocean acidification; conservation of marine areas; regulation of harvesting

of fish stocks to end overfishing; and increasing economic benefits for small island developing states and the least developed countries by the sustainable use of marine resources.

SDG 15 calls for the: conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems; implementation of sustainable management of all types of forests; halting of deforestation and restoring degraded forests; combatting desertification, by restoring degraded land and soil; reducing the degradation of natural habitats; halting the loss of biodiversity; and integrating ecosystem and biodiversity values into national and local planning and development processes.

The biosphere and prosperity for all

SDGs 14 and 15 are most directly concerned with conserving and protecting the biosphere¹³² 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 of human well-being and indispensable for human survival. The Millennium Ecosystem Assessment Report¹³³ *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:

1. **Provisioning services** – the resources provided by ecosystems that can be directly used for human activities – such as food, timber, biomass, water, and substances for producing medicines
2. **Regulating services** – the regulation of ecosystem processes that provide benefit in a direct or indirect way to human well-being – including climate regulation, water regulation, water and air purification, erosion control, and pollution
3. **Cultural services** – the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, recreation, and aesthetic experiences. Examples are spiritual and religious values, knowledge, educational values, quality of social relations, cultural heritage values, recreation and tourism
4. **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 – for example, soil formation, photosynthesis, nutrient cycling

¹³² 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.”

¹³³ Millennium Ecosystem Assessment, Available at: <https://millenniumassessment.org/documents/document.357.aspx.pdf>

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,¹³⁴ have estimated that the global value of ecosystem services in 2011 to be USD 125 trillion per year. In comparison, the world GDP in 2011 was USD 73 trillion.¹³⁵

According to Sir Robert Watson, former co-chair of the Millennium Ecosystem Assessment and chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES): "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."

Below water, on land – challenges and transformation

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.

The transformation of the biosphere driven by humans after the industrial revolution has gone so far and so fast that many leading scientists have proposed to acknowledge that we have transitioned from the Holocene into a new geological era, named "Anthropocene". Along with exiting from the safe temperature range of the Holocene,¹³⁶ the Anthropocene is going to witness what is called the "sixth extinction" – a collapse of the number of living species determined by human activities, comparable to events that have struck our planet only five times in over three billion years.

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 – protecting and nourishing the biosphere – is a key priority. Such a change requires a holistic perspective in national and international planning and development. Some of the major challenges faced today are outline below.

a) Life below water

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

- » Beyond a certain threshold, many marine organisms, for example 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 stock.
- » Altering the way marine life process carbon - ocean acidification may seriously impact the "carbon sink" function which is the ability to absorb CO₂, aggravating climate change patterns.

Ocean pollution includes the introduction of harmful substances into the ocean. One of the most important ocean pollutants today is plastic.¹³⁷ Over 150 million tonnes of plastic waste are already in the ocean and an additional eight million tonnes leaks in 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 chains; and toxic substances affecting marine species and human health.

According to a FAO report,¹³⁸ "the fraction of fish stocks that are within biologically sustainable levels has exhibited a decreasing trend, from 90 % 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 capture¹³⁹ 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.

b) 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

¹³⁷ World Economic Forum, "The New Plastics Economy Rethinking the future of plastics", 2016.

¹³⁸ The status of world fisheries and aquaculture, FAO, 2018, Available at: <http://www.fao.org/3/I9540EN/I9540en.pdf>

¹³⁹ Primary factors are: Illegal, unreported and unregulated (IUU) fishing, mismanaged subsidies to fisheries and lack of capabilities and resources to support appropriate fisheries management.

31.6 % of global land area in 1990 to 30.6 % 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),¹⁴⁰ 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 0.0 % during the five-year period, 2010-2015). The bad news is that the recent data¹⁴¹ indicates that deforestation¹⁴² 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 Republic of Congo. This trend is alarming as forests have a crucial role¹⁴³ in 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.

Soil¹⁴⁴ 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 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.¹⁴⁵ *The Status of the World's Soil Resources*¹⁴⁶ report published by FAO in 2015 indicates that "33 % 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

¹⁴⁰ This is another hot topic debated by specialists in the field – that is to what extent planted forests are comparable to natural forests in terms of supporting biodiversity and providing ecosystem services.

¹⁴¹ WRI Global Forest Watch, 2017.

¹⁴² 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.

¹⁴³ 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).

¹⁴⁴ 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."

¹⁴⁵ 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."

¹⁴⁶ Status of the World's Soil Resources. Main Report, 2015, Available at: <http://www.fao.org/policy-support/resources/resources-details/en/c/435200/>

persistent degradation of dryland ecosystems, such as land turning into desert, by human activities. Causes include unsustainable farming, mining, deforestation, overgrazing, clear-cutting of land and overexploitation of water resources. All of these can be further aggravated by droughts 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.

The role and results 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 call for 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 can obtain substantial contributions from all components of a QI.

QI institutions provide an essential contribution in terms of: measurement capabilities; a repository of good practice; support to management; monitoring, reporting and verification of compliance through the provision of trusted laboratory reports, and inspection and certification reports.

Over the past 20 years, numerous voluntary standards on fisheries and aquaculture have been published along with testing, inspection and certification schemes, and international agreements reached. They are intended to provide 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 should rise.

¹³⁴ R. Costanza et al., "Changes in the global value of ecosystem services", 2014.

¹³⁵ The World Bank.

¹³⁶ See Rockstrom et al.

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.

An example is the common benchmark for fishery certification schemes, The Global Benchmark Tool,¹⁴⁷ developed by the Global Sustainable Seafood Initiative (GSSI) with FAO's technical support. The tool includes requirements that certification schemes for both capture fisheries and aquaculture need to meet in order to demonstrate that they are based on the principles and requirements of the main FAO instruments dealing with sustainability in these areas.

GLOBAL SUSTAINABLE SEAFOOD INITIATIVE

The Global Sustainable Seafood Initiative (GSSI) was created to fill the need for a globally accepted tool to provide an objective and transparent assessment of the performance and provide recognition of credible and responsible seafood certification schemes.

The GSSI is a multi-stakeholder initiative with the mission to deliver a common, consistent and globally applicable benchmarking tool for seafood certification schemes. Its goal is to ensure confidence in the supply and promotion of sustainable seafood to consumers worldwide, as well as guide improvement in seafood certification schemes.

The path forward

Protecting and nurturing life on land and below water is indispensable for people's well-being and in the longer term, 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 reversed. A QI that includes metrology, standards, accreditation institutions and the conformity assessment service providers for testing, inspection, certification, and market surveillance, is well suited to tackle these challenges. A QI can also provide technical support and best practices, facilitating access to international networks.

¹⁴⁷ GSSI (2015), "Global Benchmark Tool – Confidence in certified seafood". Available at: <https://www.ourgssi.org/assets/GSSI-Benchmarking-Tool/GSSI-Global-Benchmark-Tool-V.1-October-2015.pdf>





7. THE FUTURE OF QUALITY INFRASTRUCTURE

National and regional QI institutions - standardization, metrology and accreditation, and the conformity assessment services they provide - will continue to play a fundamental role in achieving the 2030 Agenda and the SDGs. The future of QI needs to be sustainable and consider prosperity, people and the planet. However, in order to achieve this, QI development needs to undergo a paradigm shift.

Countries differ in their QI priorities and capacities and in a large number of countries QI has undergone constant evolution. Initially, QI was for economic growth through trade, involving the development of QI institutions and the enhancement of national capabilities for standardization, metrology and accreditation. The aim has been to expand a country's export base, increase domestic and foreign investment, and demonstrate conformity to international standards.

QI then developed for globalization, with the focus moving to conformity assessment and private standards. This led to a systemic approach to QI, driven by private sector needs, linking the private sector to consumers, sector-specific QI and sustainability standards. QI next evolved to ensuring quality and standards along specific value chains and will continue to evolve with modernization and progress towards the 4th Industrial Revolution.

With modernization comes new challenges, such as climate change, migration, global trade and technological transformation. In particular, the speed of technological transformation is bringing about disruptive changes. New technologies of Industry 4.0 such as blockchain, artificial intelligence, big data and cloud computing will have an impact on production, society and people. They will pave the way for new production methods and will need new standards, as well as new quality requirements, to be developed in order to establish best practices and regulate the use and application of the new technologies.

STANDARDS FOR ARTIFICIAL INTELLIGENCE AND BIG DATA

As the future progresses, huge growths in the commercial application of AI are expected.

Standardization in the field of AI and big data can serve as an advocate in everything related to AI, and ensure that national priorities are taken into account. Furthermore, it can provide guidance to other technical committees that develop applications related to artificial intelligence. The current standards under development in this field are:

ISO/IEC WD 22989 *Artificial Intelligence. Concepts and terminology*

ISO/IEC NP 23894 *Information Technology. Artificial Intelligence. Risk Management*

ISO/IEC NP TR 24028 *Information Technology. Artificial Intelligence. Overview of trustworthiness in Artificial Intelligence*

This means that a transformation of QI is needed to leverage the new technologies. With technological transformation, there are also increasing risks. Standardization, in particular, will still continue to play a key role in minimizing risks, setting clear and common requirements, and will ensure sustainability and alignment with the circular economy.

Standards also help move innovation forward, which is crucial for the development of new technologies. Therefore, QI institutions and services need to be strengthened in order to meet new patterns of production, new sets of requirements and adapt to changing economies and new realities.

Establishing an appropriate quality policy underpinned by the principles of ownership, inclusiveness, coherence, optimization and sustainability will help identify future needs and will ensure that the associated QI is sustainable.

This can substantially assist nations in driving the required changes while also positioning their economy to seize the many opportunities available through the 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 related to QI have evolved that underpin the SDGs while facilitating trade and protecting the health and safety 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/other requirements of international recognition arrangements of organizations (including those of the members of the INetQI, notably the ISO, IEC, ITU, BIPM, OIML, ILAC and IAF).

These, together with the new requirements embedded in standards, technical 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 new technologies and organizational methods to improve their work, and support public authorities in designing and implementing public policies aligned with the SDGs.

As a member of the INetQI, UNIDO makes an important contribution to the transformation needed. 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 quality policy and a quality infrastructure to implement it. Such programmes are two of the specialized services that UNIDO offers among its overall activities to promote inclusive and sustainable

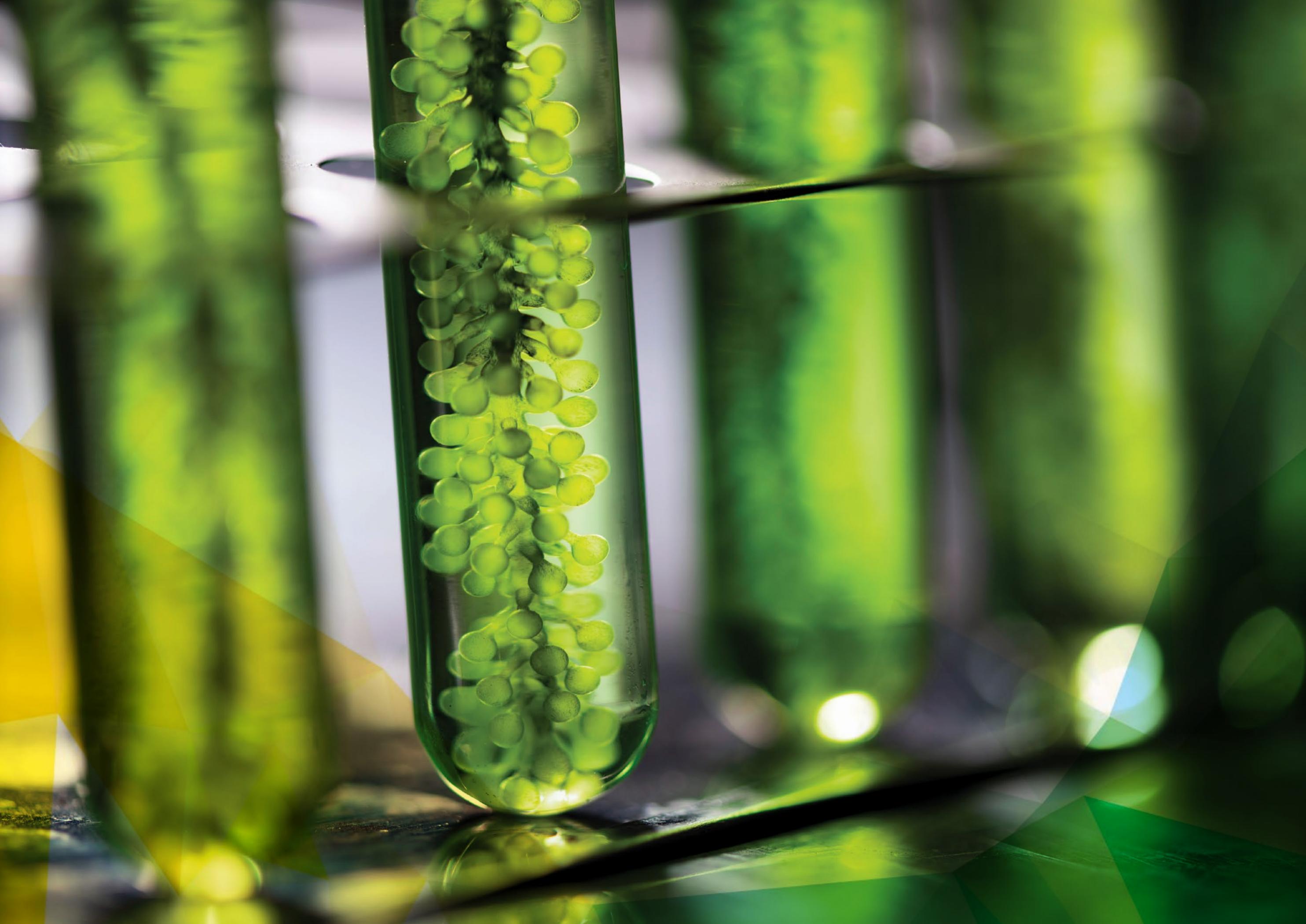
industrial development (ISID). This approach offers developing countries and economies in transition opportunities to eradicate poverty and develop sustainably. ISID helps them to build up their industrial base as a platform for social inclusiveness, economic competitiveness, environmental sustainability and integration within the global trading system.

As a first step, UNIDO can offer training to increase the understanding of QI and how to leverage on the opportunities it provides. 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 partnership and collaboration with stakeholders on collective actions based on shared objectives.

This publication is intended to assist in providing insights and examples of how QI contributes to a sustainable future. It also provides information on the role of members of the INetQI in helping countries address QI-related needs for overall sustainable development.

With this information, countries will be better placed to review and enhance 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 A

International Quality Infrastructure Organizations

1. Metrology

1.1 International Organization of Legal Metrology (OIML)

The OIML is an 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 the 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 certification 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 (BIPM)

The International Bureau of Weights and Measures (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 acronym, the 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:

- » Coordinate the world-wide measurement system, ensuring it provides comparable and internationally accepted measurement results
- » Represent the world-wide measurement community, aiming to maximize its uptake and impact
- » 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 states to allow such countries to participate in the CIPM MRA, and as a stepping stone to becoming member states.

The CIPM Mutual Recognition Arrangement (CIPM MRA) is the framework through which NMIs demonstrate the international equivalence of their measurement standards and the calibration and measurement certificates they issue. The outcomes of the Arrangement are the internationally recognized (peer-reviewed and approved) [calibration and measurement capabilities \(CMCs\)](#) of the participating institutes. Approved CMCs and supporting technical data are publicly available from the [CIPM MRA database \(the KCDB\)](#). The CIPM MRA provides a backbone for the 60,000 plus accredited calibration and testing laboratories worldwide by giving them access to peer reviewed capability worldwide. It integrates seamlessly with the ILAC MLA.

The BIPM, OIML, ILAC and ISO have drawn up a joint declaration on metrological traceability and encourage other bodies to declare their support for the principles and practices embodied in this declaration wherever possible.

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.

The 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 healthcare. 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 SDGs.

The ISO Committee on Conformity Assessment (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).

2.2 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 9,000 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.

2.3 The International Telecommunication Union (ITU)

The ITU is the United Nations' specialist agency for

information and communication technologies – ICTs. It allocates a 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 a 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.

2.4 Other standards-setting organizations

The FAO/WHO Codex Alimentarius, International Plant Protection Convention (IPPC), and The World Organisation for Animal Health (OIE), also create standards. The contracting parties/members of these treaties/agreements agree to cooperate in the development of international standards.

For example, Codex standards and related texts are voluntary in nature. They need to be translated into national legislation or regulations in order to be enforceable. 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 WTO TBT Agreement.

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 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 the 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.





- 1 NO POVERTY**
- 2 ZERO HUNGER**
- 3 GOOD HEALTH AND WELL-BEING**
- 4 QUALITY EDUCATION**
- 5 GENDER EQUALITY**
- 6 CLEAN WATER AND SANITATION**
- 7 AFFORDABLE AND CLEAN ENERGY**
- 8 DECENT WORK AND ECONOMIC GROWTH**
- 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE**
- 10 REDUCED INEQUALITIES**
- 11 SUSTAINABLE CITIES AND COMMUNITIES**
- 12 RESPONSIBLE CONSUMPTION AND PRODUCTION**
- 13 CLIMATE ACTION**
- 14 LIFE BELOW WATER**
- 15 LIFE ON LAND**
- 16 PEACE, JUSTICE AND STRONG INSTITUTIONS**
- 17 PARTNERSHIPS FOR THE GOALS**



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ISBN: 978-3-200-06742-4