IMEKO'S COMMITMENT TO THE UNITED NATIONS GOALS

"The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), an urgent call for action by all countries developed and developing in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth, all while tackling climate change and working to preserve our oceans and forests."

IMEKO, working through its General Council and especially its Technical Committees, has a major opportunity and a key role to play in providing the basis for the better technical measurement systems needed globally to allow these Goals to be achieved and their achievement verified, underpinned by the work on measurement standards at our national metrology laboratories.

Technical Committees (TCs) are asked to consider their response in terms of alignment to some or more of the technical goals shown and to look at ways to support research and dialogue into the better measurement systems needed to be used worldwide.

This may mean developing technical meetings within the remit of one or more TCs with an explicit focus on a UN Sustainable Goal and supporting initiatives, for example, in Schools and Universities, to show how IMEKO recognizes and addresses its role in this field as the International Measurement Confederation.

TC Chairs are asked to liaise with each other (and the members of the General Council as appropriate) to create explicit proposals for activities that address this global concern and, in that way, to show IMEKO activities as not only a force for good but an organization committed to action in these key areas."

Message from the IMEKO Presidential Board

TECHNICAL COMMITTEE 3 MEASUREMENT OF FORCE MASS TORQUE AND GRAVITY

"It is often difficult to demonstrate a link between metrology fields like mass or electricity with the big societal themes because these fields contribute to the general measurement infrastructure which underpins nearly everything", with an interesting link to the recent UNIDO brochure "The Role of Metrology in the Context of the 2030 Sustainable Development Goals" which, in the section on physical metrology, states:

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

"In preparing this report, the SDGs were grouped into three categories: People, Planet, and Prosperity. The conclusion was that most of the CMCs in General Physics (AUV, EM, L, M, PR) are considered to contribute to Prosperity (SDGs 7 to 11). It is obvious that as the starting point in any given country is invariably supporting industry, innovation and infrastructure, so we can conclude that if a country has any CMCs in the KCDB, it can be considered as contributing to prosperity."

It's not easy to find specific TC3-related activities that map directly onto the SDGs; the area of wind energy research is the best example to think of, but the idea that the national standards we develop and support and underpin international industrial infrastructures should be highlighted."

(By Michael Stock)

GOAL 3 Ensure healthy lives and promote well-being for all at all ages: Reliable and accurate measurement of torque and force for the development of the implant's strength and endurance.

GOAL 7 Ensure access to affordable, reliable, sustainable and modern energy for all: Force and torque metrology (static and non-static) in energy production and consumption, as well as efficiency determination of power sources and motors, see WindEFCY project at https://www.ptb.de/empir2020/windefcy/home/

GOAL 11 Sustainable cities and communities: Force and torque measurements to develop more resilient structures (earthquake-proof buildings, overloading, understanding of structure dynamics including stress distribution)

GOAL 12 Responsible consumption and production: Ensuring conformity assessment in global trade; enabling efficient use of natural resources by measurements of power consumption, use of material minimizing losses, enabling energy and material-efficient manufacturing processes by measurements in the production chain minimizing the amount of postprocessing and the amount of raw material needed.

GOAL 17 Partnerships to achieve the goal: Capacity building international conferences, congresses, and committees with open access information enables capacity building globally. Trade use of a global system of units and promoting its use minimizes the effects of global barriers to trade; the use of ISO 17000 series of standards for conformity assessment supports global trade.

(By Mikolaj Wozniak and Fredrik Arrhen)

TECHNICAL COMMITTEE 4, MEASUREMENT OF ELECTRICAL QUANTITIES

GOAL 4 Quality education: IMEKO always encouraged and helped young researchers join the community, participating in conferences and corresponding social events. Most young researchers are teaching at their institution, and the workshops and conferences organized by IMEKO help them widen their knowledge, meet new fields and discuss new methods with colleagues. These experiences can be well utilized in the teaching activities at their home institutions, resulting in better, higher-quality education.

IMEKO has always been a bridge, a meeting place between scientific research conducted in higher education institutes and Research & Development institutions. This foundation can drive innovation in that generally assumed Knowledge Triangle (KT). It highlights the importance of jointly fostering research, education and innovation, paying due attention to the linkages between them. University actors in the KT are at the core of the innovation web, where enhanced capacities, a high degree of integration and leadership are prerequisites for scaling up innovation performance. However, KT mechanisms are still rather weak in universities; cooperation with the industry sector is very low and mostly based on individual contacts, while a systematic approach is missing.

Furthermore, engineering education has kept pace with neither the advances in engineering technologies nor the demands of the labour market. The current practice is deficient in providing employees from the industry with continuous delivery of engineering competencies and a strong multi-disciplinary educational and training background. In fact, traditional education systems show limited effectiveness in developing employees' and students' competencies for the current and future Industry 4.0 environment. The educational paradigm needs to be revised to effectively address the emerging challenges in engineering education and skill demands. Modern concepts of training, industrial learning, and knowledge transfer schemes are required to contribute to improving the performance of the industrial sector, and the introduction of knowledge triangle mechanisms presents itself as one of the solutions to overcome the identified problems.

GOAL 5 Gender equality: Our community's goal is to increase the number of female researchers. Female colleagues can eventually become role models for future generations, making the engineering career more attractive to ladies.

GOAL 7 Affordable and clean energy: In response to the threat of climate change and the global challenges in the Energy sector, IMEKO has pledged to support the challenge of low-carbon energy. Renewable energy technologies, storage, smart electric grids, and energy efficiency are key segments that will help in massive decarbonization. However, the global challenges in the Energy sector cannot be successfully addressed without the contribution of knowledge-based innovations drawing on education and research in the Energy field.

New innovative solutions are requested in all spheres of transforming the Energy sector. Clean Energy production (gas and electricity) is not feasible without exact measurements of input and output process variables and smart control of the production process. A particularly important role plays electrical measurements for renewable sources of electrical energy (wind, water, solar), where often the control mechanisms have to be maximally optimized and driven by external conditions (illumination, flow or wind intensity, users energy demand, distribution network status) to achieve optimal production efficiency (e.g., MPPT converters for solar systems). This high-efficiency level cannot be achieved without exact measurements of external parameters.

GOAL 9 Industry, innovation and infrastructure: One of the main topics of IMEKO is becoming more and more important in each of the areas listed above: the number of sensors is growing year by year in the digital infrastructure around us, and more and more data need to be processed as accurately and efficiently as possible. Furthermore, we need to model increasingly complex processes with accurate mathematical models. IMEKO significantly contributes to these challenges since theoretical and practical aspects play an important role in the community's research.

Nearly all industrial processes today use electricity to power the involved appliances directly or indirectly (e.g., by powering the air compressor, which is then used to power the machines by pressurized air). Also, most control and communication signals in an industrial environment are electrical. These signals must be accurately measured to achieve efficient and safe industrial production. Also, many innovations in industrial areas are based on energy savings and achieving higher efficiency or speed of industrial processes. All these aspects can be adequately evaluated only when accurate and reliable measurements are in place.

GOAL 10 Reduced Inequality: Less access to information and knowledge is also a form of inequality. Nowadays, much knowledge is available online for free; only the required tools and internet access are needed. IMEKO's activities in sensor development and telecommunications help produce cheap and reliable devices that are affordable for those in a difficult financial situation. This contributes to the possibility of their education, resulting in a better quality of life.

GOAL 11 Sustainable cities and communities: An important criterion for sustainability is that we have an accurate estimate of the number of goods used, and on the other hand, we can determine where there is room for further optimization based on the high amount of available data. Measurement theory and techniques can help produce accurate, cheap sensors providing the necessary information for sustainability, and data processing optimization techniques can be used to recognize suboptimal use of resources, making it easier to identify the necessary changes.

All modern infrastructures in cities and communities are based on electrical communications (Internet, telephone) and appliances (from street lights to conference presentation devices, e.g., beamers). To assure proper function and optimal performance (including minimum power consumption), an exact measurement of related electrical quantities (from power measurements to interference analysis) is needed.

GOAL 12 Responsible consumption and production: consider optimization of consumption and production; it is the first step to knowing how much energy or raw materials are consumed. Also, to assess the achieved optimized, possibly self-sustainable balance between consumption and production, exact measurements of quantities that are either directly electrical (electricity power consumption, noise interfering with communication signals, etc.) or transformed into an electrical domain by an appropriate sensor (e.g., light, sound/vibration, fuel, volume and flow meters) are essential.

TECHNICAL COMMITTEE 6 DIGITALIZATION

Digital technologies can empower people in small and emerging countries to participate in international trade and the economy. One important element is that with digitalized processes in the quality infrastructure, access to markets becomes more readily available for more people, supporting the SDGs "No Poverty" and "Reduced Inequality". The digital transformation of the quality infrastructure is a significant aim of IMEKO TC6, bringing together experts from around the globe, both large and small economies.

Health, agriculture, climate observation, and urban infrastructures are sectors with the rapid uptake of digital technologies, such as sensor networks, cloud technologies, artificial intelligence, and smart sensors. The IMEKO TC6 activities in metrology for digitalization and digital technologies in industry and science support these developments, which underpin SDGs "Zero Hunger", "Good Health and Well-being", "Clean Water and Sanitation", "Industry, Innovation and Infrastructure", "Climate Action" and "Sustainable Cities and Communities". For instance, only with reliable measurements of consumption, air quality, water quality and other factors that influence the quality of life and well-being improvements can be achieved in a sustainable way. Measures to support these SDGs need to be approved and assessed quantitatively for trust and confidence in the resulting decisions. Digital technologies, such as low-cost measuring sensor networks, cloud computing, and smart mobile devices, support the implementation of such measurements under harsh conditions and in regions with few financial possibilities.

The comparability of measurements can also be improved using digital technologies, such as machine-readable certificates, cloud solutions, digital communication, and remote assessments. Hence, digital technologies for traceability of measurements can bring metrology to every place on earth, helping to assess and improve the quality of products and life standards.

Like all IMEKO Technical Committees, TC6 "Digitalization" is a place for collaboration, sharing of knowledge and experience, and bringing together people from around the world irrespective of their origins and societal background. The TC6 events on digital technology are open to everybody. With the possibility of virtual attendance, many more people can join the meetings and discussions.

TECHNICAL COMMITTEE 7 MEASUREMENT SCIENCE

The research activity related to TC7 and linked to UN goals includes studies on:

- Soft measurement,
- Uncertainty evaluation,
- Social science,
- Econometrics,
- Measurement of indicators,
- Evaluation of the impact of action,
- Risk assessment,
- Well-being measurement,
- Measurability,
- Education assessment,

- Inter-subjectivity,
- Machine learning,
- Measurement of human activity,

GOAL 1 No poverty: TC7 research on soft Measurement, social science, Measurement of indicators, evaluation of the impact of actions, and risk assessment.

GOAL 3 Good health and well-being: Well-being measurement, Measurability, Soft Measurement

GOAL 4 Quality education: Education assessment

GOAL 7 Affordable and clean energy: Measurement uncertainty and conformance assessment

GOAL 9 Industry, innovation and infrastructure: Measurement uncertainty,

conformance assessment, data fusion, machine learning

GOAL 10 Reduced inequality: Soft Measurement, Intersubjectivity, Measurability, Machine learning

GOAL 11 Sustainable cities and communities: Risk assessment, sensor networks

GOAL 12 Responsible consumption and production: Measurement of human activity

GOAL 16 Peace and Justice Strong Institutions: Social science

GOAL 17 Partnerships to achieve the goal: Econometrics, risk assessment

TECHNICAL COMMITTEE 8 TRACEABILITY IN METROLOGY

TC8's four subcommittees' contributions:

<u>Subcommittee 1:</u> Classic traceability and its application today: Measurement standards to ensure the metrological traceability of measurement results.

GOAL 9 Industry, innovation and infrastructure

GOAL 11 Sustainable cities and communities

GOAL 17 Partnerships to achieve the goal

<u>Subcommittee 2:</u> Traceability in digitalization: digital calibration certificates, virtual worlds/ digital twins

GOAL 9 Industry, innovation and infrastructure

GOAL 11 Sustainable cities and communities

GOAL 13 Climate action

GOAL 17 Partnerships to achieve the goal

<u>Subcommittee 3</u> Special issues, e. g., vanishing standards during calibration/ testing in chemistry: establishment of metrological traceability in chemical measurement by the use of certified reference materials.

GOAL 6 Clean water and sanitation

GOAL 7 Affordable and clean energy

GOAL 9 Industry, innovation and infrastructure

GOAL 13 Climate action

GOAL 17 Partnerships to achieve the goal

<u>Subcommittee 4;</u> Interdisciplinary traceability what do we have in common; what can we learn from one another; redefinition of the system of units (SI) and effects on traceability: an integrated approach to metrological traceability with the contribution by different measurement fields.

GOAL 9: Industry, innovation and infrastructure

GOAL 11: Sustainable cities and communities

GOAL 13: Climate action

GOAL 17: Partnerships to achieve the goal

TECHNICAL COMMITTEE 10 MEASUREMENT FOR DIAGNOSTICS, OPTIMIZATION AND CONTROL The TC's activities are related to the following goals:	GOAL 7 Affordable and clean energy GOAL 9 Industry, innovation and infrastructure GOAL 11 Sustainable cities and communities GOAL 12 Responsible consumption and production
TECHNICAL COMMITTEE 14 MEASUREMENT OF GEOMETRICAL QUANTITIES GOAL 3 Good health and well-being: 1. The use of modern measurement techniques for measurements of geometrical quantities, whose development and constant improvement is one of the TC14 aims, is crucial for supporting the design, implementation and production of innovative medical devices used for diagnostics and therapy. 2. The possibility of running advanced research on internal and external structures, including surface topography of new materials used in bioengineering, assists the progress in producing implants or artificial organs. 3. Methods of geometrical error identification and correction are used to improve the accuracy of radiotherapy devices and devices used for medical imaging (computed tomography and magnetic resonance imaging scanners) GOAL 7 Affordable and clean energy: 1. Large-volume metrology systems, which are also in the scope of TC14 works, give the possibility to perform precise measurements	of large-size elements of wind and water turbines, enabling, for example, optimal selection of the shape of these elements. 2. Low-force tactile and computed tomography measurements are crucial elements of the quality inspection of solar panels. GOAL 9 Industry, innovation and infrastructure: TC14 works on the development of innovative quality assessment systems comprising measurement methods, techniques, infrastructure and procedures for technical quality control at all stages of production of nano products, photovoltaic devices, modern optical elements, space exploration vehicles, powertrain systems, means of transport and many more. The scope of TC14's work also includes quality assessment of finished products in the abovementioned areas, including assessing their functional properties with modern measurement techniques. GOAL 12 Responsible consumption and production: Implementing quality control loops makes production processes robust against disturbances, reducing scrap to the utmost minimum and optimizing the consumption of resources.
TECHNICAL COMMITTEE 15 EXPERIMENTAL MECHANICS GOAL 4 Quality education: TC15's traditional event, the Youth Symposium on Experimental Solid Mechanics, is focused primarily on students. GOAL 9 Industry, innovation and infrastructure: TC15 and UN Goal 9 have a very strong relationship.	TC15 Experimental mechanics primarily focuses on developing and transferring technologies for industry 4.0. detailed structural and deformation analysis and participation in smart (meta)material development and testing. GOAL 12 Responsible consumption and production: this goal could be partly met by our activities in the testing of additively manufactured (zero waste technology)

structures. Additive manufacturing is inherently optimized for resource material consumption and produces no waste. Moreover, the materials used for this method are highly recyclable, and the energy	efficiency of production is positive. For this reason, AM products and structures are extensively investigated from a Metrologic and load-bearing capacity point of view.
TECHNICAL COMMITTEE 16 PRESSURE AND VACUUM MEASUREMENT Pressure and vacuum measurements touch our everyday lives. Pressure drives turbines and pistons that produce the vast majority of mechanical energy. Vacuum measurements are critical to semiconductor processes in producing computer chips, LEDs for our light bulbs, solar panels, and lithium-ion batteries. Pressure and vacuum measurements underpin the efficient production of most synthesized chemicals, food packaging/sterilization, pharmaceuticals, and advanced technology products. Specifically, here are some ways that TC16 addresses the UN's sustainable development goals: GOAL 3 Good health and well-being: For many applications (Oxygen lines in hospitals and blood pressure), real-time pressure monitoring is a crucial measurement.	Sphygmomanometer and eye-tonometry are crucial to the health goal. Leaks for leak testing radiation containment vessels. Vacuum Requirements: for semiconductor fabrication for healthcare, the production of healthcare items, pharmaceuticals, and vaccines.GOAL 7 Affordable and clean energy: Vacuum Requirements for solar panel production and thin films. For semiconductor fabrication for energy, sustainability, the production of batteries for energy storage, and the production of thin-film coatings on glass to prevent heat transfer. GOAL 9 Industry, innovation and infrastructure: Vacuum leaks are crucial for the industry. GOAL 12 Responsible consumption and production: The atmospheric leaks, developing a device to measure and record temperature, relative humidity and air pressure with digitalization criteria.
TECHNICAL COMMITTEE 20 MEASUREMENTS OF ENERGY AND RELATED QUANTITIES Goal 7 Affordable and clean energy: TC 20 is constantly striving to put digitalization at the forefront, keeping in mind the UN Goals on sustainability, especially UN Goal 7. For various applications, the TC has interdisciplinary working groups in renewable and sustainable clean energy (solar, wind, electro and synfuels). We work together worldwide with regulatory bodies, industry	NGOs, Universities, and premier institutions offer them platforms to disseminate their work and foster open discussions to enable the UN sustainability goals of affordable, clean and sustainable energy, protect our environment and mitigate climate change. An example of such a platform is our international conference on hydrogen this April with NGOs, Ministries, Universities, Industries, Standardisation Bodies and NMIs. https://www.imeko-gh2fuels.ptb.de/
TECHNICAL COMMITTEE 21 MATHEMATICAL TOOLS FOR MEASUREMENTS GOAL 3 Good health and well-being: Traceable measurement in health, data analytics, uncertainty quantification. Trace-able environmental measurement, e.g.,	quantification GOAL 6 Clean water and sanitation: Traceable environmental measurement, data analytics, uncertainty quantification. GOAL 9 Industry, innovation and infrastructure:

Traceable industrial measurements, data analytics, uncertainty quantification reference methods for data analysis (including decision-making and experiment design)

GOAL 13 Climate action: Traceable measurement of key climate variables, data analytics, uncertainty quantification

GOAL 14 Life below water: Traceable environmental measurement, e.g., air quality, data analytics, uncertainty quantification.

GOAL 15 Life on land: Traceable environmental measurement, e.g., air quality, data analytics, uncertainty quantification

GOAL 16 Peace and justice strong institutions International scientific collaboration

GOAL 17 Partnerships to achieve the goal: International scientific collaboration

TECHNICAL COMMITTEE 22 VIBRATION MEASUREMENT

The work of IMEKO TC22 supports 5 of the 17 UN sustainable development goals, namely goals 3, 7, 9, 11 and 16, as detailed below.

GOAL 3 Good health and well-being: Vibration measurements contribute to human health and well-being.

- Safety and comfort of automotive vehicles and trains (crash tests, suspension testing);
- Seismic (earthquake) monitoring to assure the health and well-being protection of the community;
- Monitoring of human exposure to vibration;
- Wearable personal health and fitness monitoring devices.

GOAL 7 Affordable and clean energy: Vibration measurements play an important role in the realization of wind energy. The implementation of wind energy is often hindered by inhabitants in the neighbourhood of the turbines due to the fear of generated (low frequency) noise and vibration, but objective measurements can help to base the discussion on facts and turn the public opinion. In addition, Vibration measurements are widely used for predictive maintenance and optimization of operation parameters of wind power generators.

GOAL 9 Industry, innovation and infrastructure:

- Smart digital accelerometers play an important role in IoT and the 4th cost of digital motion sensors are contributing to the development of new products and applications, with the current range of applications covering automotive vehicles, drones, gaming consoles, smartphones, smartwatches, robots, and factory automation.
- Vibration isolation and vibration measurements are used worldwide for monitoring production processes to yield high-quality products.
- For the development of resilient and sustainable infrastructure, vibration measurements provide a means of infrastructure health diagnosis, and it is essential that the measurements be objectively reliable.

GOAL 11 Sustainable cities and communities: The support of wind energy and resilient infrastructure, discussed under goals 7 and 9, also supports goal 11. In addition, the work of TC22 is important for earthquake countermeasures, for which accurate amplitude and phase of seismic vibration measurements are necessary. Beyond that, vibration measurements are currently used to monitor and estimate the structural health of buildings to perform predictive maintenance and to increase the service lifetimes of public infrastructure.

GOAL 16 Peace and justice strong institutions: Low-frequency vibration measurements support the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) regarding the International Monitoring System (IMS).

The IMS, when completed, will include 50 primary and 120 auxiliary seismic monitoring stations distributed worldwide.

With the implementation of metrological traceability to the SI, the reliability and trustworthiness of such measurements will be emphasized.

TECHNICAL COMMITTEE 24 CHEMICAL MEASUREMENTS

GOAL 3 Good health and well-being: Chemical measurements in the biomedical field allow physicians to make decisions after reliable analyses.

GOAL 4 Quality education: Metrology in chemistry contributes to ensuring that all students acquire the knowledge and skills needed to promote sustainable development.

GOAL 6 Clean water and sanitation: Metrology in chemistry is essential to have common standards for drinkable water and detect possible contaminations.

GOAL 7 Affordable and clean energy: Energy Companies require new and advanced analytical techniques to develop environmentally friendly fuels. Expertise in chemical measurements is needed to implement the transition towards renewable gaseous fuels.

GOAL 9 Industry, innovation and infrastructure: Chemical measurements are important to model and assess risk in industrial plants.

Harmonization in chemical labelling is essential to developing common procedures and best practices.

GOAL 12 Responsible consumption and production: The development of reliable and durable materials and the optimization of industrial processes are strongly supported by chemical measurements, which allow us to model the interaction between the material and the environment correctly.

GOAL 13 Climate Action: Metrology in chemistry is fundamental to assessing pollution levels in air and land and thus supports policy decisions. Carbon dioxide capture is made possible by developing primary standards, sampling procedures, and analytical methods supporting industries in this activity.

GOAL 14 Life below water: Metrology in chemistry is the basis for estimating and quantifying the degree of contamination in different aquatic environments, such as rivers, lakes, and oceans. Water acidification and microplastic pollution monitoring require standardized methods to be correctly performed.