

Analysis of Quality Infrastructure Services Offered in Kenya and Potential for Development

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On behalf of



On behalf of the Federal Government of Germany, the Physikalisch-Technische Bundesanstalt promotes the improvement of the framework conditions for economic, social and environmentally friendly action and thus supports the development of quality infrastructure.

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1. Main findings from the Kenya country study

A brief overview of the overall level of relevance of key sectors at national level, their priority in terms of climate change and opportunities identified for further development of quality infrastructure in Kenya is presented in the following table.

Recommendations

Based on the results from the national study in Kenya, three main recommendations can be deduced in relation to the overall relevance of analysed key sectors at the national level, their priority in the context of climate change and opportunities for future development of quality infrastructure therein.

1. Climate change adaptation is considered a priority in the political agenda of Kenya and thus the Kenyan government appears to be a relevant and suitable cooperation partner for designing and implementing quality infrastructure-related projects for response to climate change. Up to now, the demand for quality infrastructure services in times of climate change is not being identified and considered systematically by the national quality infrastructure organizations. Fostering the cooperation between the relevant sectors (especially water, agriculture and meteorology and renewable energy) and the quality infrastructure organizations and supporting the development of the needed quality infrastructure services can be seen as an important opportunity in this context.
2. For the time being, agriculture will remain the economic backbone of Kenya. At the same time, the sector is a) affected continuously by climate variability and extremes, and considered to be most severely affected by climate change, while b) the vast majority of the country's greenhouse gases are emitted from this source. At the same time, basic quality infrastructure services needed by the sector are already offered, which could be further expanded and improved. Therefore, putting a focus on quality infrastructure services related to climate change in the agricultural sector appears to be most relevant and promising in the overall development context of Kenya. Close linkages exist however between the agricultural and the water sectors and meteorology, hence it might be worthwhile to evaluate possible joint approaches.
3. Considering the regional scale, meteorological services provided by the Kenya Meteorological Department not only offer meteorological services nationally,

but serve – in cooperation with the World Meteorological Organization (WMO) – global meteorological databases, weather forecasts and climate projections for the whole East African region. Important cooperation opportunities especially exist in the calibration of the equipment used in the Regional Instrument Centre in Kenya and the support of its accreditation. Project activities fostering the cooperation between meteorology and quality infrastructure could result in pilot cases which are also highly interesting for other developing economies.

2. Kenya's background

Political and economic context of Kenya

President Uhuru Kenyatta has governed Kenya since 2013 with The National Alliance (TNA) party. The Kenyan government's national long-term development plans aim at economic transformation through the "Kenya Vision 2030" which aims at transforming Kenya into a newly industrializing, middle-income state providing high quality

	Relevance at national level	Priority in climate change context	Opportunities for quality infrastructure development
Renewable Energies	<ul style="list-style-type: none"> As part of Kenya's national long-term development plan "Vision 2030", more energy at lower cost is planned to be produced. Renewable energies (geothermal, solar and wind power) will be strengthened. 	<ul style="list-style-type: none"> National Climate Change Action Plan suggests expansion in renewables and clean energy options. Hydroelectricity generation is affected by climate extremes such as droughts. Decreasing hydroelectricity generation can lead to increased greenhouse gas emissions. 	<ul style="list-style-type: none"> At present, there is a low quality infrastructure development status and a low demand for quality infrastructure services. Yet, demand is potentially to increase in the future with higher awareness of importance of quality in the sector.
Energy Efficiency	<ul style="list-style-type: none"> As part of Vision 2030, efficiency in energy consumption is planned to be increased. New regulations exist on energy efficiency in buildings. 	<ul style="list-style-type: none"> Enhancement of energy and resource efficiency (over the long run) is envisaged in National Climate Change Action Plan. 	<ul style="list-style-type: none"> At present, there is low quality infrastructure development status in metrology and testing. Higher demand can be expected with new standards and Kenya Energy Label.
Meteorology	<ul style="list-style-type: none"> As part of the Social Strategy of Vision 2030, rehabilitation of the hydro-meteorological data gathering network is envisaged. National Meteorological Department of Kenya has a hub function for the entire East African region. 	<ul style="list-style-type: none"> Sector is criticized for lacking reliability of forecasts. Quality of meteorological observations is particularly important for near time forecasts and calculation of climate trend prediction. 	<ul style="list-style-type: none"> There are important needs for a) calibration and, possibly, b) accreditation. Unified processes for quality assurance and data sharing are needed.
Agriculture	<ul style="list-style-type: none"> As part of Vision 2030, processing and adding value to agricultural products is aimed at. Need for better soil and land management, resilient seeds, high quality pesticides and fertilizers. 	<ul style="list-style-type: none"> Climate change forecasted to lead to declining production levels. Sector impacted by water scarcity and reduced soil productivity (e.g. erosion). Resilience along agricultural value chain is set as priority in National Adaptation Plan. 	<ul style="list-style-type: none"> Basic quality infrastructure services already offered. Development opportunities in specific standards, testing and metrological services. Agriculture as priority area for the German Ministry for Economic Cooperation and Development (BMZ) in Kenya.
Water	<ul style="list-style-type: none"> As part of the Social Strategy of Vision 2030, improved water and sanitation shall be made available to all. Commercially oriented water service provision is formalized and regulated. 	<ul style="list-style-type: none"> Water scarcity is an important topic in the public perception. Water scarcity combined with reduced water quality and quantity increases water-borne diseases and affects water pricing. 80% of Kenya's land is already today classified as arid and semi-arid. 	<ul style="list-style-type: none"> Need to improve the existing test bench for water meters (could serve as regional reference). Need for accreditation of testing laboratories. Water and sanitation priority area for BMZ in Kenya.
Human Health	<ul style="list-style-type: none"> As part of Vision 2030, an efficient, high quality health care system is planned. 	<ul style="list-style-type: none"> Risk of climate-sensitive (food-, water- and vector-borne) diseases. Existing national health adaptation strategy. Development of malaria early warning system. 	<ul style="list-style-type: none"> At present, relatively low demand for quality infrastructure services. Interest in developing legal metrology and secondary calibration labs. Health as priority area for BMZ in Kenya.

Status of relevance/priority/opportunities	High	Medium	Low
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Table 17: Relevance, priorities and opportunities for quality infrastructure development in relation to climate change in Kenya

life to all its citizens by 2030. The Vision focusses on three key pillars: economic, social and political development (UNDP 2017), and is to be implemented in successive five-year medium-term plans. Flagship projects integrated in the Vision 2030 include different thematic areas which coincide with the focus areas of this study.

Kenya is classified as a lower middle-income country, with an average per capita GDP of USD 1,450. The country's Human Development Index is 0.555, which is slightly higher than the average 0.523 of the total average of Sub-Saharan Africa countries (UNDP 2015). However, Kenya's Corruption Perceptions Index worsened to 26 in 2016, in comparison to 25 in the two previous years of 2015 and 2014 (Transparency International 2017). As expressed in the stakeholder interviews, corruption is still and will remain a central concern in Kenya's political-economic context.

Agriculture represents the backbone of Kenya's economy, contributing to over one-third of the national GDP. About 80% of Kenya's workforce engages in farming or food processing. Kenya produces tea, coffee, maize, cattle, horticulture and sugarcane, among other things. Small-scale, rain-fed farming or livestock production represents the majority of Kenya's agricultural output. Besides agriculture as the most important economic sector, the tourism, services, transport and communication sectors, as well as mining, are important for the country's economy both in terms of revenue generated as well as in the overall workforce engaged.

Evidence of climate change in Kenya

Effects of climate change and relevant hazards

In Kenya there are several sectors which are particularly sensitive to climate change, such as agriculture (mainly rain-fed), energy, tourism, water and health. The country's economy is highly dependent on these sectors and, as a consequence, climate change is a critical issue for the country's development (MENR 2015). Extreme climate events such as droughts and floods occur more frequently. The country's drought cycles have been reduced over time and droughts recorded in the period between 2007 and 2012 were occurring on a yearly basis causing severe crop and livestock losses, famine and population displacement (MENR 2016). Exacerbated drought conditions may have significant impacts on water availability and general well-being (GoK 2016).

Excessive flooding in Kenya occurs relatively frequently. However, the annual rainy seasons are becoming wetter, causing floods and inundations. Health-related impacts as a result of floods range from waterborne to sanitation-related diseases (typhoid, cholera, malaria and diarrhoeal diseases). Floods constantly damage critical infrastructure on which the national economy depends. Poor urban planning and rapid urbanization further aggravate the situation (GoK 2016).

Sea level rise is likely to intensify floods in combination with extreme weather events. Water supply shortages, salinization problems and aquifer contamination as well as inundations in low-lying areas are risks caused by sea level rise. The agricultural sector along the coast also tends to be impacted with harvesting losses (GoK 2016).

Impacts of climate change on different areas

Energy: Hydroelectricity generation, the main source of electricity in Kenya, is affected by extreme events such as droughts. Decreasing hydroelectricity generation could lead to higher prices and greater use of fossil fuels, which increases greenhouse gas emission.

Agriculture: Roughly 70% of rural livelihoods in Kenya are dependent on rain-fed agriculture. This sector is mainly impacted by unpredictable rainfall, reduced soil productivity through erosion and increased evapotranspiration leading to a decline in agricultural production. Maize yields are predicted to increase in mixed rain-fed temperature and tropical highlands; arid and semi-arid areas will experience significant declines in crop yields.

Environment, Water and Forestry: Climate change in Kenya severely affects natural ecosystems. This leads to environmental degradation along with negative social and economic consequences for the Kenyan population. Arid and semi-arid areas for example, are particularly vulnerable ecosystems due to their dry conditions with emerging risks such as land degradation and desertification. Increasing water scarcity leads to declining forest coverage, reduced water quality and quantity for domestic use and industrial use, high water pricing and increases in waterborne diseases. Forests at risk can lose their natural ecosystem services such as soil erosion reduction, natural pest control and conservation of water availability and water quality maintenance. Greenhouse gas emissions are also increased by deforestation and forest degradation.

Human Health: Kenya's population is at a high risk for climate-sensitive infectious diseases such as food- or water-borne diseases like diarrhoea, hepatitis A and typhoid fever. Vector-borne diseases such as malaria, dengue fever and Rift Valley Fever are prevalent as well. High temperatures and intense rainfall are known to be critical factors for the initiation of malaria epidemics in Kenya (MENR 2016).

Institutional and policy framework for climate change mitigation and adaptation

In Kenya, institutional arrangements and policies for the response to climate change are widely in place. The legal framework comprises the Climate Change Act of 2016 and the Energy Act of 2006. Additionally, climate change-specific policies are framed by other policies, including the National Environment Policy and the National Policy for Disaster Management.

The Climate Change Act is very specific in terms of institutional arrangements for climate change coordination. A National Climate Change Secretariat was established under the Ministry of Environment and Natural Resources through the Climate Change Act (MENR 2016).

The Energy Act from 2006 encompasses several energy-related laws. The Act mandates the government to promote the development and use of renewable energy.

Additionally, the National Environment Policy 2013 aims to provide a framework for an integrated approach to sustainable management of Kenya's environment and natural resources. At the same time, the National Policy for Disaster Management (2009) aims at institutionalizing mechanisms to address climate change-related disasters and associated vulnerabilities (LSE 2017).

Overall, climate change is a priority on Kenya's political agenda. However, like in other countries in Sub-Saharan Africa, the implementation and enforcement of climate change policies has potential for improvements.

Climate change and national quality infrastructure institutions in Kenya lack cooperation in some areas such as accreditation in the environmental (including agriculture and water) sector. As will be mentioned in section 3.1.4 under accreditation, the Ministry of Environment and Natural Resources does not "recognize" Kenya Accreditation Service (KENAS) as an accreditation body for testing

laboratories conducting tests for its regulations. KENAS, on the other hand, is interested in developing new services related to climate change.

Climate change mitigation

Kenya's total greenhouse gas emissions amounted to 73 MtCO₂eq in 2010, which is relatively low in the global context. In Kenya, a large proportion of the population depends on charcoal as its main household fuel. The demand for agricultural land and urban expansion is increasing, which adds further strains to forest resources. Roughly 75% of greenhouse gas emissions in Kenya originate from land use, land use change and, more specifically, forestry and agricultural sectors. Energy and transport sectors, as well as waste processing and industrial processes are other important sources of emissions, even though to a lesser extent (MENR 2015).

Energy regulations on solar water heating, energy management and solar photovoltaic systems were passed in 2012 (Kenya Meteorological Department 2017). The Intended Nationally Determined Contributions (INDC) in Kenya make note of mitigation contributions towards the 2015 Climate Agreement in Paris. Kenya seeks to reduce greenhouse gas emissions by 30% by 2030 by pursuing a low carbon, climate-resilient development pathway. Although the enforcement of these regulations is lacking to a large extent, their existence establishes a direction into a climate-compatible development pathway and sets the stage for improved climate change mitigation.

Based on the National Climate Change Action Plan (NCCAP, 2013–2017), Kenya seeks to promote and implement the following mitigation activities: expansion in renewable energy (geothermal, solar and wind) and clean energy options, enhancement of energy and resource efficiency, tree covering, reduction of reliance on wood fuels, low-carbon and efficient transportation systems, climate smart agriculture and sustainable waste management systems (MENR 2015).

In the context of this study, climate change mitigation actions and policies are considered to be particularly relevant for the energy and the agricultural sectors:

- **Renewable energies & energy efficiency:** Expansion of renewable energies (geothermal, solar and wind energy), clean energy options and enhancement of energy and resource efficiency are integrated in the National

Climate Change Action Plan. Development of Nationally Appropriate Mitigation Actions (NAMAs) proposals to attract investment for biogas, solar lighting, geothermal and waste initiatives is currently under way.

- **Agriculture:** 75% of the greenhouse gas emissions in Kenya originate from land use, land use change and, more specifically, from the forestry and agricultural sectors. Reduction of greenhouse gas emissions can be achieved, for example, through agroforestry or conservation tillage. Both approaches form a central part of climate smart agriculture.

Climate change adaptation

Given a comparatively low level of greenhouse gas emissions, especially when compared to western industrialized countries, Kenya places more emphasis on the adaptation to the effects of climate change than on mitigation. Kenya aims at ensuring enhanced resilience to climate change by 2030 through mainstreaming climate change adaptation into the medium-term plans of Vision 2030 and implementing adaptation actions.

Adaptation actions presented in the National Adaptation Plan are related to several sectors, including health, environment, water and irrigation, population, urbanization and housing, tourism, agriculture, livestock development and fisheries (MENR 2015). The implementation of the National Adaptation Plan is likely to enhance long-term resilience and adaptive capacity, particularly related to droughts, floods and sea level rise. With drought being considered the main hazard, the National Drought Management Authority is a key institution in enhancing adaptive capacity (GoK 2016).

In the context of this study, climate change adaptation actions and policies are particularly relevant for the agriculture, water and health sectors:

- **Agriculture:** The overall adaptation action integrated in the National Adaptation Plan aims at enhancing the resilience of the agricultural value chains. The promotion of sustainable climate smart agriculture methods is instrumental for making the sector more resilient to the impacts of climate change. Some medium-term actions include promotion of drought-tolerant value crops, water harvesting for crop production or integrated soil fertility management.
- **Water:** The National Adaptation Plan also aims at mainstreaming climate change adaptation in the water sector. Some medium-term actions in the water sector include the strengthening of water resource monitoring and assessments for early warning and planning, as well as the promotion of technologies which enhance water resource efficiency.
- **Human health:** In the health sector, climate change is to be mainstreamed in relevant areas of the health system. A medium-term priority will be to design appropriate measures for surveillance and monitoring of climate change-related diseases in order to enhance early warning systems (MENR 2016).

Multilateral and bilateral cooperation activities

In the context of multilateral and bilateral cooperation in Kenya, activities are manifold in all sectors covered by the study presented here. In the following, initiatives and programmes implemented by multilateral and bilateral cooperation are briefly described. Given its overall economic and social importance, development partners are particularly engaged in the agricultural sector, including climate change-related projects. However, no cooperation activities are currently being implemented in the area of quality infrastructure.

Multilateral cooperation

United Nations Development Programme (UNDP): One among the four main programmes of the UNDP in Kenya is called “Environmental Sustainability, Renewable Energy and Land Management”. Two focus areas in this programme are climate change adaptation and mitigation and sustainable energy access. Additionally, chemical management is another topic in which UNDP is engaged in Kenya, supported by the Global Environmental Facility (GEF). At community level, UNDP engages in rehabilitation of natural springs and drilling of boreholes for water management (UNDP 2017).

World Bank Group (WBG): Among WBG initiatives relevant in the context of this study is the “Kenya Climate Smart Agriculture Project” which was launched in 2017. Investments are also made in other areas including agribusiness, transport, energy, water and urban development, followed by the social sectors including human health. Improvement of agrometeorological forecasting and monitoring, as well as strengthening climate-smart

agricultural research and seed systems are other topics in which WBG is engaged (World Bank 2017).

Bilateral cooperation

German Federal Ministry for Economic Cooperation and Development (BMZ): The German bilateral engagement, mainly financed by the BMZ, comprises the following priority areas: agriculture (focusing on food security and drought resilience), the development of the water and sanitation sector and support for the health sector (BMZ 2017).

German Society for International Cooperation (GIZ): The agricultural sector receives approximately 25% of the GIZ funding volume in Kenya. GIZ activities in the agricultural sector focus on innovation to increase employment, food security and drought resilience. On behalf of BMZ, GIZ is working with local and international partners to improve access to safe water, health care services and renewable energies development. One project directly related to quality infrastructure was implemented in Kenya between 2009 and 2013 by GIZ. The initiative called “African Eco-labelling Mechanism” developed African Eco-Labeling Standards (AES) in the agriculture, fisheries, forestry and tourism sectors. While the objective of these initiatives was to improve the access of African products to international markets, African economies were also supported in adapting to climate change and contributing to greenhouse gas mitigation (GIZ 2017).

German Development Bank (KfW): KfW supports Kenya in a) improving water supply and sanitation systems, b) bringing forward productive agricultural development and c) introducing a widespread healthcare system. In the energy sector, KfW puts a focus on the construction of geothermal power plants and rehabilitation of hydropower stations (KfW 2017).

3. Analysis of thematic focus areas

Renewable energies and energy efficiency

With an average economic growth rate of 4.7% between 2004 and 2017, Kenya depends on generating more energy at a lower cost while at the same time increasing efficiency in energy consumption. Therefore, Kenya’s government is committed to institutional reforms including a strong regulatory framework, encouraging private power

generators and separating power generation from distribution.

For the time being though, the topic of energy efficiency is of no crucial importance for the Kenyan government; rather, the priority is the question of how to provide more (and more stable) energy to an ever-growing population and industry.

Traditionally, Kenya has had a strong focus on hydropower production for sustaining the domestic energy market. With ever-increasing demands for energy, the further development of new energy sources such as geothermal energy is considered important. Yet, geothermal exploration remains expensive and resource-consuming.

There is a need to collect more reliable data for advancements in the development of new energy sources, in order to keep exploration costs at a calculable level. Hence, new sources of energy in focus are renewable energies such as geothermal power, but coal continues to play a role.

All in all, solar energy does not (yet) play a predominating role in the Kenyan energy sector and in the political agenda, even though potential for further development is considered high. Further advancement of rural electrification programmes is planned, based on the installation of solar electricity generators for 74 public institutions and an energy access scale-up programme (Kenya Vision 2030).

Among national institutions, the National Commission for Science, Technology and Innovation (NACOSTI) plays an important role in planning for the successful enhancement of renewable energies in the long run: NACOSTI regulates and ensure quality in the science, technology and innovation sector and advises the Government in matters related thereto. Physical science, chemistry, meteorology and geology are some of the topics covered by the Commission. However, NACOSTI has not yet sufficiently considered the relevance of quality infrastructure in their work.

Meteorology

As in other countries, meteorology is considered to be an important interdisciplinary area in Kenya which plays a central role for the provision of a sound data basis related to weather forecasting and climate change. Under the Kenya Vision 2030, some aspects of the meteorological infrastructure and services are planned to be restructured

and modernized, including the rehabilitation and further development of the hydro-meteorological data-gathering network.

Institutions relevant for meteorology in Kenya are the Kenya Meteorological Department, as a national institution, and – related to the agricultural sector – the International Centre of Insect Physiology and Ecology (ICIPE), as an international research organization.

The Kenya Meteorological Department – which belongs to the Ministry of Environment and National Resources – serves as the national and regional hub for the provision of meteorological and climatological services to agriculture, forestry, water resources management, civil aviation and the private sector. With its mandate to maintain an efficient telecommunications system for rapid collection and dissemination of meteorological information, the department has strong ties with the World Meteorological Organization (WMO) and its regional training centre (WMO-RTC), same as with the International Civil Aviation Organization (ICAO) whose procedures it aims to follow. The Kenya Meteorological Department publishes meteorological information on national level and also provides regional data for Eastern Africa to the WMO Information System.

Currently, the Meteorological Department works on the national implementation of the WMO Integrated Global Serving System, thereby fostering the sharing of meteorological data between all relevant national ministries and institutions (e.g. the ministries of agriculture and fishery). The department runs a data quality centre for analysing national as well as regional meteorological data based on models which are also used by the UK Meteorological Office (UKMET). The models applied are based on WMO Guidelines and serve the entire East African region, but according to interview partners, neighbouring national meteorological departments still use different quality monitoring models, which prevents the region from using and applying a uniform approach.

In the frame of these prevailing conditions, the International Centre of Insect Physiology and Ecology (ICIPE) aims to contribute to alleviating poverty, to ensure food security and to improve the overall health status of people living in the tropics by following an interesting both national and regional approach: Through the “Climate Change Impacts on Ecosystem Services and Food

Security in Eastern Africa (CHIESA)” project, automatic weather stations have recently been installed in different locations in Kenya, Tanzania and Ethiopia in order to assess the microclimate variability with respective national meteorological headquarters. One of the outcomes of the project was an increased capacity of the African research communities to access, collect, develop, use and manage scientific information in climate change-related matters. Against this background, it becomes clear that a) an approach for collaborating with the Kenyan Meteorological Department should not only consider the national, but importantly also the regional (Eastern African) scale, in which b) opportunities for collaborating with a meteorological institution such as DWD for supporting further development of meteorological services both in Kenya and in the region may be analysed.

While focusing on the meteorological sector, the “holy trinity” in which the agricultural and the water sector also play an important role should not be dismissed. Following a systemic approach for the whole of the three sectors might mean to be closest to meet the demands of an agriculture-dependent nation such as Kenya and its neighbouring countries.

Agriculture

Agriculture is by far the most important economic sector of Kenya, both in terms of revenue generated and the overall workforce involved. All in all, the sustainable economic development of Kenya will depend on progress to be made in economic revenues earned in agriculture in both domestic and international markets.

Based on the Kenya Vision 2030, interventions are planned in the agricultural sector following the objective of generating higher yields and adding value to farming products before they reach the market. Differences between pre-production, production and post-production levels are not yet made in the overall development strategies.

Yet, Kenya’s strategy for the agricultural sector includes preparation of new land for cultivation by developing more irrigable areas in arid and semi-arid areas (which can be titled as proper governance at pre-production levels), and by improving market access for small holders through better marketing (post-production levels). At production scale, in which quality infrastructure services play a predominantly important role, conditions are not yet sufficiently considered.

Altogether, the Kenyan agricultural growth strategy is more growth- than quality-oriented. Exemplary and relevant initiatives in the agricultural sector which are currently envisaged are, for example, a Fertilizer Cost-Reduction Initiative as well as Development Projects in arid and semi-arid land areas (Kenya Vision 2030).

Stabilizing production conditions as well as guaranteeing sufficient amounts and a steady supply of agricultural products for the domestic market is not only important for the agricultural sector, but for the overall national economy of Kenya. Soaring prices of agricultural products due to prolonged drought conditions in some parts of Kenya pushed inflation above 9% in March 2017.

Against this background, a wide range of national institutions, research institutes and international cooperation organizations are active in improving overall conditions in the agricultural sector. Among those, the International Plant & Nutrition Institute (IPNI), the Eastern Africa Grain Council (EAGC) and the World Agroforestry Centre (ICRAF) take centre stage.

As a science-based organization, the International Plant & Nutrition Institute (IPNI) covers topics of soil and crop response, fertilizers and organic resources. Climate change is a reference topic for this organization. Researchers engaged in this institution in Kenya are currently working on the crop-specific application of fertilizers. They cooperate with different laboratories such as the International Centre for Research and Agroforestry (ICRAF) or nationally recognized laboratories like the Crop Nutrition Laboratory Services (CROPNUTS).

The Eastern Africa Grain Council (EAGC) mainly supports structured grain trade in the Eastern and Southern Africa region. Being active in policy advocacy, EAGC facilitates an efficient, profitable and inclusive grain trade. The organization is active in 10 Sub-Saharan African countries, covering the trade of several grain species like maize, rice, sugar, millet etc. Members of the council are private sector actors including producers, service providers, insurance providers etc.

The World Agroforestry Centre (ICRAF) is an international centre of scientific excellence possessing the world's largest repository of agroforestry science and information. Due to its significance in testing services, further information on the centre can be found in section 3.1.4. under

“Testing”. The organization is especially innovative and active in the Kenyan context.

Water

In the water sector, Kenya aims at conserving water sources and at ensuring that improved water and sanitation are available and accessible to the whole population. Increased access to safe water and sanitation in both rural and urban areas and the promotion of agricultural productivity through irrigation are priorities at the national level. Within the water and environment sector, activities such as rehabilitation of hydro-meteorological stations, development of multi-purpose water conservation structures and dams, the rehabilitation of irrigation schemes, the implementation of sewage initiatives and the mapping of land coverage and land use are planned (Kenya Vision 2030).

During the implementation of the national study, more detailed insights into the water sector were provided by the Kenyan Institute of Environment and Water Management (IEWM) and the private company David & Shirliff. While IEWM aims at strengthening water and environmental governance and increasing climate change resilience through advocacy, research training and capacity building in Kenya, David & Shirliff aims at providing water and energy solutions in a regional context. By focusing on six principal product sectors (water pumps, boreholes, swimming pools, water treatment, generators and solar equipment), the company is the leading supplier of water-related equipment in the East African region. It was found that resolving prevailing challenges in the water sector, also in terms of quality infrastructure-related aspects including reliable and correct water metering, might comprise the involvement of both public and private institutions. Overall, an enhanced and trustworthy water metering is expected to lead to improved water management and less water shortages.

Human Health

Regarding the human health sector, according to the Kenya Vision 2030, the country aims at providing an efficient and high-quality health care system for its growing population. This includes a) devolving funds and management of health care to the communities and to district medical officers; and b) shifting the bias of the national health bill from curative to preventive care. Specific strategies involve the provision of a robust health infrastructure network and the improvement of the quality of health ser-

vice delivery. Revitalization and integration of community health centres promoting preventive health care is another priority (Kenya Vision 2030).

Over the course of the national study, a more detailed understanding of prevailing challenges for the health sector in Kenya could be achieved.

On the one hand, the Ministry of Health in Kenya is composed of different departments like the Department of Standards and Quality Assurance and Regulations, under which several quality infrastructure topics are covered. Health inspections of medical centres are primarily organized by the Ministry of Health internally, although capacities are limited. At the same time, the Ministry of Health is ISO 9001 certified while health centres are still lacking certification. Recently, the Ministry of Health in cooperation with several development partners have developed a Quality Model for Health and a training course in order to guide health managers in strengthening quality management at all levels. However, the impact of the implementation of this model has not been evaluated yet.

On the other hand, the WHO in Kenya follows a number of strategic priorities in the country which are potentially related with quality infrastructure topics covering the human health thematic area: For example, strategic priority 5 follows the objective to strengthen existing capacities for disaster preparedness, surveillance and effective response to disease outbreaks, acute public health emergencies and the effective management of health-related aspects of humanitarian disasters (WHO 2017). Therefore, there are several topics where possible links between the Ministry of Health, PTB and WHO could be defined.

4. Quality infrastructure services in relevant areas

Quality policy, regulation and important institutions

Quality infrastructure in Kenya is organized in a centralized manner, with the most relevant functions covered by the Kenya Bureau of Standards (KEBS). KEBS serves as the national standardization organization, national metrology institute and legal metrology authority. KEBS also runs the national Technical Barriers to Trade (TBT) entry point. Additionally, it acts as an inspection and certification body as well as a testing laboratory and training institute in different areas, especially those related to Kenyan Standards and quality signs emitted by KEBS. The functions and government structure of KEBS are regulated in the Standards Act 2012 (Laws of Kenya 2012). A national quality policy does not exist.

KEBS' organizational structure comprises the following divisions:

- Standards Development and International Trade Division
- Quality Assurance Division
- Testing and Metrology Services Division
- Finance and Administration Division

The National Standards Council is the policy-making body for supervising and controlling the administration and financial management of the Bureau. The Managing Director of KEBS is responsible for the administration of the organization. The organization has around 1,200 employees, including its regional offices. KEBS is nationally

Quality infrastructure status	Metrology	Standardization	Testing	Certification and inspection	Accreditation
Renewable energy					
Energy efficiency					
Meteorology					
Agriculture					
Water					
Human health					

Quality infrastructure development status	High	Medium	Low	No information

Table 18: Development status of quality infrastructure in relevant sectors

recognized as the central actor of quality infrastructure, especially in the area of standardization.

Metrology

The KEBS metrology department is one of the most advanced national metrology institutes in the region. A broad range of metrological services is offered, covering the areas included in the table below.

The functions of KEBS in the area of metrology are regulated in the Weights and Measurement Act of 2012 (National Council for Law Reporting 2012).

The metrology department is a member of AFRIMETS (AFRIMETS 2017). It became a full member of the General Conference of Weights and Measures (CGPM) of the Metre Convention and a signatory of the Committee of Weights and Measures Mutual Recognition Arrangement (CIPM-MRA) in 2010 (KEBS 2017a). The tables below summarize the intercomparisons registered under BIPM,

Calibration and Measurement Capabilities (CMC) presented and the German Accreditation Institute (DakKS) accreditations held by KEBS.

In the thematic areas considered in this study, especially the following metrological services of KEBS are of special interest:

Renewable energy and energy efficiency

For renewable energies and energy efficiency, especially the metrological services in the areas of direct current and low frequency measurements, energy and transformers as well as photometry are of interest. Also in these areas, relatively few national metrology institutes in the region offer calibration services and especially access to an AC/DC laboratory with an internationally recognized accreditation is advantageous for the industry. In the other areas mentioned, the accreditation or presentation of CMCs may be seen as an opportunity for further development.

Mechanical Metrology Laboratories	Electrical Metrology Laboratories
Mass Pressure Temperature Density and viscosity Force Volume and Flow Dimensional metrology	Time and frequency AC/DC (direct current and low frequency measurements) Energy and transformer Photometry Acoustics and vibration Dosimetry (ionizing radiation) Mechanical workshop and instrumentation

Table 19: Metrological services offered by KEBS

Registered intercomparisons under BIPM with KEBS participation	CMCs presented by KEBS
Ionizing radiation (for Kenya traceability to the BIPM in the field of dosimetry is established through BIPM calibrations made for the International Atomic Energy Agency - IAEA) Mass Time (BIPM 2017)	Acoustics, ultrasound and vibration Chemistry for food (ethanol in aqueous media and cadmium in brown rice)

Table 20: Registered intercomparisons and CMCs presented

Electrical quantities	Temperature quantities	Mechanical quantities
<ul style="list-style-type: none"> ■ DC voltage ■ AC voltage ■ DC current ■ DC resistance 	<ul style="list-style-type: none"> ■ Resistance thermometers ■ Liquid-in-glass thermometers 	<ul style="list-style-type: none"> ■ Mass (mass standards) ■ Volume of flowing liquids ■ Force

Table 21: KEBS: Metrological quantities accredited by DAkKS (DAkKS 2017)

Furthermore, important metrological services for the renewable energy and meteorology sectors are missing, for example in the areas of wind speed, humidity and solar irradiance (calibration of pyranometers).

Meteorology

KEBS offers several metrological services which could be of interest for the meteorology sector, including the Meteorological Department and the climate stations in the country. These services, among others, are offered in the areas of temperature, volume and pressure as well as time and frequency. Not all of these services are accredited, which could be seen as an area for improvement. Also, several services important for the sector are missing, including the ones mentioned above for renewable energy and energy efficiency, as well as for humidity, for example.

Agriculture

In the area of agriculture, basic metrological services such as mass and temperature are offered. However, important services for the agricultural sector are missing at present, e.g. moisture and humidity. As described in section 2.4 on agriculture, the provision of traceability in these areas will be of increasing importance in times of climate change.

Water

For the water sector, especially the area of flow is of interest, as only few national metrology institutes in Sub-Saharan Africa offer services in this area. As part of a PTB project, a test bench for water meters was installed. It can be used for the calibration of flow meters of up to 250 mm. The national water providers do not have the required equipment to calibrate macro water meters. For this reason, the calibration of micro as well as macro meters is a service frequently offered by KEBS.

Human health

The demand for calibrations in the health sector has been relatively low in the past. As the demand for these services, especially by hospitals, rises, KEBS is now planning to expand its services in this area. KEBS envisages supporting hospitals in enhancing their internal calibration laboratories, e.g. in the areas of temperature, mass, conductivity and pressure.

Secondary metrology laboratories

Secondary calibration laboratories offer a broad range of services. A total of 14 secondary calibration laboratories are accredited by KENAS, covering among other things

the areas of mass, pressure, temperature, weighing scales, water and power meter calibration, force, time, torque and volume (KENAS 2017a).

An important secondary calibration laboratory in the scope of this study is the laboratory of the Meteorological Department in Nairobi. The laboratory serves as a Regional Instrument Centre (RIC) of the World Meteorology Organization (WMO). This means that it serves as a calibration laboratory not only for the national weather stations, but also for Tanzania, Uganda, Ruanda, Burundi, Ethiopia, Djibouti, Sudan and Eritrea. The laboratory offers calibration of the most important equipment used in weather stations (for temperature, humidity, rainfall, pressure and radiation) but not for wind speed.

Contacts between KEBS and the Meteorological Department on the calibration of the equipment of the calibration laboratory were initiated, but were not met with interest. For this reason and as no further calibration services are used (e.g. via WMO) at present none of the equipment of the laboratory is calibrated. Intercomparisons (e.g. with other meteorological calibration laboratories) are not done frequently and not for all of the methods applied.¹ The calibration of the equipment and the realization of intercomparisons seem to be important areas for a potential cooperation with the organizations of quality infrastructure (e.g. KEBS), especially considering its role as Regional Instrument Centre.

At present, the laboratory is not accredited. Training and consultancy to support the implementation of ISO 17025 and posterior accreditation could be seen as another important area for cooperation with the quality infrastructure institutions.

Legal Metrology

The Department of Weights & Measures of the Ministry of Industry, Trade and Cooperatives is responsible for legal metrology in Kenya. The legal basis of the department is defined in two Acts of Parliament, namely the Weights and Measures Act, Cap. 513, and the Trade Descriptions Act, Cap. 505 (State Department of Trade 2017). The department is a member of the OIML (OIML 2017). Its services are available throughout the country through 21

¹ According to its latest update report from May 2017, the RIC Kenya participated in intercomparison measurements for pyranometers and resistance thermometers. Additional information will be available on the website of WMO shortly.

“Zonal Offices” (State Department of Trade 2017). The organization has 100 inspectors in total.

In the thematic areas considered in this study, the following information on the current status of legal metrology in Kenya is of special interest:

Renewable energy and energy efficiency

At present, the verification of electricity meters is only based on document checks. The Legal Metrology Department is in the procurement process of a test bench for electricity meters.

Meteorology

No specific legal metrology services are offered in the meteorology sector.

Agriculture

In the area of agriculture, regulations for fertilizers and pesticides exist, but the implementation is not being inspected. According to the information received, this is mainly due to the lacking resources of the authorities.

Water

For water meters, a certificate in country of origin is required. The certificates are checked by the Legal Metrology Department. For new models, a process of pattern approval and initial verification is required. The measurements required are conducted by KEBS. In this context, it must be considered that the flow laboratory of KEBS is not accredited, so that the results of a pattern approval could be mistrusted, for example in a lawsuit. Inspectors may check whether the requirements are fulfilled, but due to capacity restrictions very few inspections are realized.

Human health

At present, the legal metrology capacities in the health sector are rather limited and only include pressure and temperature. Also in this sector, no inspections are being conducted by the Legal Metrology Department.

Standardization

KEBS is Kenya's standardization body under the Ministry of Industry, Trade and Cooperatives. KEBS is a member of the International Organization for Standardization (ISO) (with participation in a relatively high number of Technical Committees [TCs]) (ISO 2017) and a member of the ARSO (ARSO 2017).

In March 2009, Kenya launched a new requirement for imports. In addition to the pre-shipment verification of conformity, imported products must also obtain an import standards mark (ISM) issued by KEBS. Fake ISMs were found on the packaging of counterfeit products entering Kenya already before the ISM was legally required (Privacy Shield Framework 2017).

In the thematic areas considered in this study, the current stage of standardization may be summarized as follows:

In the *renewable energy* sector, it was mentioned that specific standards for technologies such as photovoltaic and solar water heating would be needed.

In the area of *energy efficiency*, KEBS has recently adopted 10 energy performance standards and test procedures, developed with the support of the United Nations Industrial Development Organization (UNIDO) between Tanzania, Uganda, Rwanda and Burundi. The following products are covered: electric motors, air conditioners, compact fluorescent lamps, fluorescent lamps, fluorescent ballasts and refrigerators. In Kenya, these products will be marked with the Kenya Energy label (UNDP 2017). In this context, it must be considered that at present there are no energy efficiency laboratories in Kenya (the section on “Testing” see below).

In the area of *meteorology*, at present there are no specific Kenyan standards, as processes and methods are mainly defined in WMO internal guidelines.

In the *agricultural* sector, many standards exist for general agricultural processes and specific commodities. KEBS/Kenya took over the Food and Agriculture Organization/World Health Organization (FAO/WHO) Codex Coordinating Committee for Africa from 2016 for 2 years (FAO 2016).

In the *water* sector, several standards define the criteria for equipment and processes needed for drinking water and waste water management.

In the *human health* sector, several interview partners mentioned that criteria for products with potential health impacts are defined in Kenyan Standards, but that more specific standards on processes and management systems in public health institutions would be needed.

Currently, standards and technical regulations are not being clearly differentiated in Kenya. In this context, KEBS is defined as “regulatory body (...) mandated to develop and ensure compliance with (...) product standards” (Export 2017). All Kenyan product standards become legally binding after being gazetted, with KEBS being the only certification body allowed to certify based on these standards. This practice is not compliant with international requirements and good practices. It results in unnecessary barriers to trade and ineffective quality control mechanisms.

These policy and organizational issues can be seen as more relevant than the existence or lack of all standards relevant for the thematic areas considered in this study. The most important areas in this context seem to be covered in the Kenyan standard system, including for example standards on greenhouse gases and solar water heaters. According to KEBS, there is a need to standardize climate resilient varieties in the agricultural sector, to define standards for water and carbon foot printing and to create a validation scheme for CO₂-emissions. Stakeholders of the agricultural sector confirm the need for new standards for varieties as well as on the composition and origin of seeds. Some stakeholders mentioned that the lacking implementation of standards is an important issue. For example, grains used in food and beverage production are only tested every four months by KEBS.

Testing

At present, 17 testing laboratories and 21 clinical laboratories in Kenya are accredited by KENAS (KENAS 2017b). The areas covered include microbiology, chemicals, agriculture, water, food safety, human health and drugs. At present, there is no laboratory association or network to support the collaboration between testing laboratories.

In the thematic areas considered in this study, the following information on the current status of the testing capacities in Kenya is of special interest:

In the *renewable energy* sector, there are very limited capacities in important services required for an effective quality control, for example testing of photovoltaic modules. The area of energy efficiency is currently not covered by any testing laboratories. This leads to the situation that compliance of products with the energy performance standards (see the “Standardization” section above) and the Kenya Energy label may not be tested in the country.

In the *agricultural* sector, there are only few soil laboratories, as the demand for soil testing at present is limited. Some tests required by the sector are not offered in Kenya, so that producers have to send their samples to other countries.

Only three accredited laboratories offer water tests. None of the public institutions are accredited. This can be seen as an important gap, as they are the main laboratories involved in the monitoring of drinking and waste water.

In the *human health* sector, there are accredited laboratories both in public and private organizations, including individual laboratories as well as internal laboratories in hospitals and research organizations.

In the following, two laboratories which are especially interesting in the context of the study are described more in detail.

KEBS Testing Department

The KEBS Testing Department offers its services in the areas of chemistry, food, microbiology, material engineering and textiles. The testing services are offered to both internal and external customers. Product tests are carried out against national standards, international standards, specific government and other client specifications (KEBS 2017b). According to information provided by KEBS, the laboratories comply with ISO 17025. However, at present none of the laboratories are accredited.

In the thematic areas considered in this study, the following information on the current status of the KEBS testing laboratories is of special interest:

The gas laboratory conducts tests of industrial and vehicle emissions, including CO₂. The equipment is calibrated with reference gases purchased in South Africa. Based on these reference gases, the laboratory also provides calibration services for other laboratories in Kenya.

The electrical laboratory at present has basic equipment for testing energy electrical quantities. Based on this equipment, also the current of photovoltaic modules is being tested. At present, no further tests relevant for energy efficiency or renewable energies can be provided, but it is planned to expand the testing services in these areas in the future.

World Agroforestry Centre (ICRAF)

The World Agroforestry Centre (ICRAF) is a scientific centre generating science-based knowledge about the roles which trees play in agricultural landscapes. The centre receives its funding from many different partners including governments, private foundations, international organizations, regional development banks and the private sector.

The testing laboratory of ICRAF is part of the Africa Soil Information Service (AfSIS) and of the Global Soil Spectroscopy Network. As such, it serves as a hub for the creation and exchange of information on the characteristics of soils in Africa, which is used, for example, for the elaboration of digital maps on soil quality.

Together with a German provider of laboratory equipment, ICRAF has developed innovative dry testing methods for soils using mobile devices (such as an alpha near infrared spectrometer for soil characteristic analysis and an X-ray spectrometer). These devices make the testing of soil parameters in the field possible, increasing efficiency substantially. Besides soil, the X-ray spectrometer can also be used for plant and fertilizer analysis, for example. Carbon and nitrogen in soil and plant samples are analysed with a gas chromatograph.

The laboratory uses National Institute of Standards and Technology (NIST) reference material to calibrate most of its equipment, e.g. plant leaves, reference gases and soil samples. In this context, it was stated that specific reference material for Africa with high element values is lacking.

The laboratory is not accredited, as the accreditation is seen as too costly and not flexible enough to adapt to new procedures developed as part of ICRAF's research activities.

Certification and inspection

KEBS acts as a certification body for products, systems and personnel. The certifications are realized based on Kenyan as well as international standards. In the thematic areas considered in this study, the following certification services of KEBS are of special interest:

- ISO 14001 Environmental Management Systems
- HACCP Food Safety Management Systems
- ISO 22000 Food Safety Management Systems
- ISO 50001 Energy Management Systems

- ISO 13485 Medical Devices
- Personnel certification compliant with ISO 17024 (KENAS 2017c)

As of September 2005, KEBS implemented the Pre-Export Verification of Conformity programme (PVoC) to ensure that regulated products imported into the country comply with the applicable Kenyan Standards and/or Technical Regulations. SGS is the only company authorized to provide the service worldwide and has been operating the PVoC programme in Kenya for the last seven years. All consignments of regulated products need to obtain a Certificate of Conformity (CoC) issued by SGS prior to shipment of the goods. The CoC is a mandatory document for customs clearance in Kenya. Any cargo arriving to destination without the CoC will be denied admission into the country (SGS Group 2012). The KEBS Certification Body is accredited by the Dutch Accreditation Council (KEBS 2017c). Other relevant private certification bodies include the following: SGS Kenya, Bureau Veritas and InterTek Services.

Relevant inspection bodies in Kenya include the following:

- **KEBS:** Among other things, inspection of goods at Port of Entry.
- **Kenya Plant Health Inspectorate Service (KEPHIS):** Inspection of all imported plant materials.
- **Pest Control Products Board (PCPB):** Registration of all agricultural chemicals imported to or distributed in Kenya based on test results. It also inspects and licenses all premises involved in the production, distribution and sale of the chemicals.
- **Kenya's Pharmacy and Poisons Board (PPB) and the Ministry of Health:** Inspection and registration of all pharmaceutical drugs manufactured or imported into the country (Export 2017).
- Private inspection bodies, for example SGS Kenya.

Six private and no public inspection bodies in Kenya are accredited by KENAS (KENAS 2017d). Especially the public inspection bodies do not have sufficient trained staff to effectively ensure compliance with quality and safety criteria in their area of competence.

There are plans to build up an inspection scheme for green buildings, which would be relevant for the thematic area of energy efficiency. Other interview partners indicated that there are plans to develop specific inspection schemes for hydropower and geothermal power plants.

Accreditation

KENAS is the national accreditation body. It is an organization with its own budget under the Ministry of Industry, Trade and Cooperatives. It is a member of the International Accreditation Forum (IAF) and an associate member at the International Laboratory Accreditation Cooperation (ILAC). The organization has 37 staff members (a relatively high number) and 60 assessors. Authorities finance approximately 75% of the organization, while 20% of the funding is generated through training activities and 5% is provided by external partners (e.g. PTB or the EU).

Currently, KENAS is in the international recognition process. Last year, the organization was peer-evaluated by AFRAC and ILAC in the areas of testing laboratories, medical laboratories, certification and inspection bodies. Currently, the observations are being implemented; the Mutual Recognition Agreement (MRA) could be signed earliest this year.

KENAS offers accreditation services in the following areas:

- a. Certification bodies
 - Management Systems ISO/IEC 17021
 - Personnel ISO/IEC 17024
 - Products, processes and services ISO/IEC 17065
- b. Testing and calibration laboratories ISO/IEC 17025
- c. Medical laboratories ISO 15189
- d. Inspection and verification bodies ISO/IEC 17020
- e. Proficiency test providers ISO/IEC 17043
- f. Reference medical laboratories ISO/IEC 15195
- g. Veterinary laboratories ISO/ IEC 17025 & OIE

A challenge for KENAS is its lacking recognition by some authorities in Kenya and the missing inclusion of quality criteria for conformity assessment in the relevant technical regulations. For example, the Ministry of Environment and Natural Resources has an own system to “recognize” testing laboratories which may conduct tests according to its regulations, without making reference to an accreditation by KENAS. Another example is clinical laboratories which do not have to be accredited according to the relevant technical regulations.

KENAS sees new services related to climate change as an important strategic area for its future development. Among other things, the organization plans to offer accreditation of certification bodies for energy management systems and of organizations offering CO₂ emission verification.

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