

# Analysis of Quality Infrastructure Services Offered in Ethiopia 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.

## 1. Main findings from the Ethiopia country study

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

### Recommendations

The following main recommendations can be made based on the results from the Ethiopia country study, taking into consideration 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.

1. A number of strategies for climate resilient development have been launched between 2011 and 2015 by different Ethiopian ministries indicating commitment of the Ethiopian government, especially in the agriculture, water and energy sectors. These sectors are particularly relevant, due to their high exposure to risks in times of climate change. Quality assurance and related services have not been systematically taken into consideration in these strategies. Raising awareness about possible benefits and thus supporting the collaboration between ministries, quality infrastructure organizations and private sector actors could foster a more efficient and effective implementation of climate change adaptation and mitigation efforts.
2. For the agriculture and water sectors, a number of relevant quality infrastructure services already exist. An ongoing PTB project is to further strengthen quality infrastructure for innovations related to agriculture. It could be an opportunity to expand the scope of a possible follow-up project to support quality infrastructure services with relevance for climate change adaptation efforts for the agriculture and water sectors. Clear linkages between the two sectors exist. Cooperation efforts could also support specific services for the meteorological sector, given the importance of reliable climate data for the other sectors and the expressed interest in expanding services for this sector on the side of the Ethiopian national metrology institute. An example of strong collaboration between

metrology and meteorology could foster similar developments in other countries in the region.

3. Climate change-related projects in Ethiopia are mainly carried out by multilateral cooperation partners, like UNDP and World Bank, with quality topics being addressed only marginally. German development partners in Ethiopia are particularly engaged in the education, agriculture and natural resource management sectors. There is no clear focus on climate change yet. Nevertheless, due to the existing national priorities and new climate change-related strategies, a potential cooperation with Ethiopia with this focus can be seen as an opportunity. Supporting the development or improvement of relevant quality infrastructure services could also complement efforts of other German development partners in the areas of drought resilience or renewable energies, for instance.

## 2. Ethiopia's background

### Political and economic context of Ethiopia

Ethiopia is located in the Horn of Africa and has a population of more than 99 million people. It is the second-most populous country in Sub-Saharan Africa with a population growth rate of 2.5% in 2015. At the same time, it is also one of the world's poorest countries. The overarching goal of the government's Growth and Transformation Plan (GTP II, 2015/16 to 2019/20) is to turn Ethiopia into a lower-middle-income country by 2025. In order to achieve this, Ethiopia is especially committed to ensuring growth through enhancing the productivity of agriculture and manufacturing, improving the quality of production and stimulating competition in the economy (World Bank 2017, FDRE 2016).

With an average per capita GDP of USD 706, Ethiopia is classified as a low-income country. The country's Human Development Index is 0.448, which is lower than the average 0.523 of the total of Sub-Saharan African countries (UNDP 2015). Furthermore, Ethiopia's Corruption Perception Index scored at 34 in 2016. Over two-thirds of the 176 countries in the world in 2016 fall below the midpoint of the scale of 0 (highly corrupt) to 100 (very clean). Based on this index, Ethiopia is perceived as less corrupt than its neighbours, including Kenya and Uganda (Transparency International 2017, World Bank 2017).

	Relevance at national level	Priority in climate change context	Opportunities for quality infrastructure development
Renewable Energies	<ul style="list-style-type: none"> <li>The Climate Resilient Green Economy strategy includes exploitation of hydropower.</li> <li>Energy potentials of the country are prioritized in order of importance as follows: hydroelectric power, geothermal energy, wind and solar power.</li> </ul>	<ul style="list-style-type: none"> <li>Due to the energy mix in Ethiopia, the country's vulnerability to climate change is high.</li> <li>Dependence of Ethiopia's hydropower sector on rainfall is emphasized in national climate resilience strategies.</li> <li>Expansion of renewable energies is integrated into the Intended Nationally Determined Contributions (INDC).</li> <li>The Water and Energy Climate Resilience Strategy was launched in 2015.</li> </ul>	<ul style="list-style-type: none"> <li>Currently low development status and low demand for services of quality infrastructure.</li> <li>The importance of services is well understood by representatives of quality infrastructure and increase in demand expected.</li> </ul>
Energy Efficiency	<ul style="list-style-type: none"> <li>The Climate Resilient Green Economy strategy mentions energy efficiency topics aiming at energy efficiency investments in the electric power generation sector.</li> </ul>	<ul style="list-style-type: none"> <li>Switch to modern and energy efficient technologies in transport, industry and building sectors integrated in Ethiopia's Intended Nationally Determined Contributions (INDC).</li> </ul>	<ul style="list-style-type: none"> <li>At present, low-quality infrastructure development.</li> <li>Higher demand is expected due to increasing interest in the topic.</li> </ul>
Meteorology	<ul style="list-style-type: none"> <li>In Ethiopia's second Growth and Transformation Plan, the meteorological contribution emphasizes on agro-, hydro- and bio-meteorological forecasting and early warning.</li> <li>Meteorology sector is closely inter-linked with other sectors.</li> </ul>	<ul style="list-style-type: none"> <li>The Water and Energy Climate Resilience Strategy entails data systems development for decision-support (rainfall, temperature data).</li> <li>The Agriculture and Forestry Climate Resilience Strategy includes activities such as capacity building and institutional coordination for climate information.</li> </ul>	<ul style="list-style-type: none"> <li>Some services in metrology available.</li> <li>National metrology institute expressed interest to expand its services in the area.</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>The agricultural sector development plan follows an acceleration and sustained growth of agriculture within the framework of the Climate Resilient Green Economy strategy.</li> </ul>	<ul style="list-style-type: none"> <li>The agricultural sector is particularly sensitive to climate change in Ethiopia.</li> <li>51% of the greenhouse gas emissions in Ethiopia originate from agriculture related activities including livestock.</li> <li>The Agriculture and Forestry Climate Resilience Strategy was launched in 2015.</li> </ul>	<ul style="list-style-type: none"> <li>Basic quality infrastructure services are available.</li> <li>Development opportunities in specific metrological and testing services.</li> </ul>
Water	<ul style="list-style-type: none"> <li>Activities in the second Growth and Transformation Plan include water supply, irrigation and drainage development, hydropower studies, surface and groundwater studies.</li> </ul>	<ul style="list-style-type: none"> <li>Demand for water is likely to rise and impacts of climate change may act as an additional stressor, affecting the quantity and quality of water resources.</li> <li>The Water and Energy Climate Resilience Strategy was launched in 2015.</li> </ul>	<ul style="list-style-type: none"> <li>Some basic services exist, but important gaps remain.</li> <li>Need for accreditation of testing laboratories.</li> </ul>
Human Health	<ul style="list-style-type: none"> <li>The actual Growth and Transformation Plan primarily aims at providing equitable, accessible and quality primary health service. The focus lies in implementing primary health care at all levels of the health delivery system</li> </ul>	<ul style="list-style-type: none"> <li>Health impacts of climate change will be felt through an increase in vector-borne and non-vector borne diseases as well as injury and mortality through floods and storms, etc.</li> <li>Existing national health adaptation strategy.</li> </ul>	<ul style="list-style-type: none"> <li>Basic quality infrastructure services are offered.</li> <li>Some potential for improvement and expansion of specific services.</li> </ul>
<b>Status of relevance/ priority/ opportunities</b>			
	High	Medium	Low

Table 22: Relevance, priorities and opportunities for quality infrastructure development in relation to climate change in Ethiopia

As one of the fastest growing non-oil producing economies in Africa, Ethiopia has sustained a high annual growth since 2004. Currently, 80% of the country's employment comes from the agricultural sector. However, other areas such as industry are increasingly gaining importance (UNDP 2017).

### Evidence of climate change in Ethiopia

#### Effects of climate change and relevant hazards

Average temperatures in Ethiopia have increased over the past century and human induced climate change will bring even further warming, which is likely to be associated with heat waves and higher evapotranspiration. Regarding the future distribution, timing and intensity of rainfall there is much uncertainty. Moreover, a higher regularity in heavy rainfall events is expected, which is likely to result in increased flooding. Altogether, the most vulnerable sectors to climate change include health, agriculture, water, energy, buildings and transport (crgevision 2011, FDRE 2015). Impacts of climate change on different areas

**Energy:** Even though the vast majority of Ethiopia's national energy needs are met with fuel wood, crop and animal waste human and animal power, 95% of electricity generated in Ethiopia comes from hydropower. Furthermore, the hydropower sector is yet to be fully developed within the country. Due to this energy mix, the country's vulnerability to climate change is very high. The reliance on fuel wood and charcoal brings widespread land degradation and a major exposure of soil to erosion. At the same time, energy generated by hydropower is vulnerable to fluctuations in rainfall, temperature and evaporation.

**Agriculture:** The agricultural sector is a very climate-dependent sector and therefore particularly vulnerable to the future impacts of climate change. As a consequence, developing climate resilience is especially crucial for the agricultural sector in Ethiopia. Climate change impacts on the sector include increases in soil erosion and higher incidences of crop damage. Furthermore, socioeconomic phenomena such as demographic pressures and degradation of land area worsen the already critical situation. Changes in pest and disease frequency, in cropping patterns and drought and flood damages are other impacts which may affect the agricultural sector (crgevision 2011).

**Water:** Ethiopia has relatively abundant water resources and to date, only a small proportion has been developed

for sectors such as hydropower, agriculture and water supply and sanitation. Nevertheless, demand for water is likely to rise as these sectors develop. Impacts of climate change may act as an additional stressor, affecting the quantity and quality of water resources, especially in low rainfall areas such as the lowlands (USAID 2012).

**Human health:** The health impacts of climate change will be felt through different climate-relevant health outcomes such as higher mortality rates through extremes temperatures, increases in vector-borne (e. g. malaria) and non-vector borne diseases (diarrhoeal diseases and cholera associated with floods and droughts) as well as injury and mortality through floods and storms etc. Already today, 68% of Ethiopians live in malaria risk areas (crgevision 2011).

#### Institutional and policy framework for climate change adaptation and mitigation

Since Ethiopia ratified the UNFCCC in 1994, some efforts have been made on climate-related issues in the country. The late Prime Minister, Meles Zenawi, initiated efforts to fight climate change in Africa and to generate green growth in the country and in the region. In 2011 the government finalized its Climate Resilient Green Economy strategy for integrating measures of economic performance with those of environmental performance, such as improving resilience to climate shocks, mitigation of greenhouse gas emissions and biodiversity loss and ensuring access to clean water and energy. In August 2015, two reports which present climate resilience strategies for the agriculture and forestry and the water, irrigation and energy sectors in Ethiopia were launched by the Ministry of Environment and Forest (MEF), the Ministry of Agriculture (MoA) and the Ministry of Water, Irrigation and Energy (MoWIE).

Even though there is no legal framework in place, institutional arrangements and policies for responding to climate change are given in Ethiopia (LSE 2017, GGGI 2017).

#### Climate change mitigation

Ethiopia's total greenhouse gas emissions amounted to 150 MtCO<sub>2</sub>eq in 2010. About 42% of greenhouse gases were emitted by livestock, 9% by crop cultivation and 37% by deforestation and forest degradation. The electric power generation, transport, industrial and building sectors emitted the remaining 12%. Just as in other countries in Sub-Saharan Africa and considering Ethiopia being the

second-most populous country in Sub-Saharan Africa, its emissions are very low. The Intended Nationally Determined Contributions (INDC) in Ethiopia intend to limit its net greenhouse gas emissions in 2030 to 145 MtCO<sub>2</sub>eq or lower. Through the implementation of the Climate Resilient Green Economy strategy, a resilient economic development pathway in the country and a decrease in greenhouse gas emissions is likely to be achieved (FDRE 2015).

The Ethiopian National Energy Policy (updated in 2012) was developed in order to comprehend new energy development-related issues and to give emphasis to the development and utilization of all renewable energy sources. The existence of this policy sets the ground for improved climate change mitigation (Ministry of Water and Energy 2013).

Just as in Kenya, in the context of this study, climate change mitigation actions and policies are considered to be particularly relevant for the energy and the agricultural (including livestock) sectors.

- **Renewable energies and energy efficiency:** The expansion of renewable energies and the switch to modern and energy efficient technologies in transport, industry and building sectors are activities integrated in Ethiopia's Intended Nationally Determined Contributions (INDC). Additionally, the Ethiopian Energy Authority (EEA) and the Green Economy strategy aim at implementing some energy efficiency strategies of interest for this study such as a national energy efficiency labelling programme and energy audits in the industrial, commercial and public sectors.
- **Agriculture:** 51% of the greenhouse gas emissions in Ethiopia originate from agriculture-related activities including livestock. Reduction of greenhouse gas emissions can be achieved, for example, through intensification of agriculture supported by the use of improved inputs and better residue management, development of irrigation infrastructure and the introduction of lower emission agricultural techniques (FDRE 2015).

### Climate change adaptation

Ethiopia intends to undertake adaptation initiatives to reduce the vulnerability of its population to the adverse effects of climate change through the implementation of the Climate Resilient Green Economy strategy. The strategy mentions the sectors of the economy most vulnera-

ble to climate change as being agriculture, health, water and energy, buildings and transportation. The Ministry of Water Resources and the Meteorological Service finalized Ethiopia's first Climate Change National Adaptation Programme of Action (NAPA) in 2007. Later in 2010, the NAPA was updated and replaced by the Ethiopian Programme of Adaptation to Climate Change (EPACC) (FDRE 2015, LSE 2017).

In the context of this study, climate change adaptation actions and policies are particularly relevant for the energy, agriculture and water sectors, for which climate resilience strategies were launched in 2015:

- **Renewable energies:** Within the Water and Energy Climate Resilience Strategy, the dependence of Ethiopia's hydropower sector on rainfall is stressed. Due to the potential of hydropower generation shortfalls, the diversification of the energy mix is planned to be reinforced in order to spread the risk.
- **Agriculture:** The Agriculture and Forestry Climate Resilience Strategy in Ethiopia includes adaptation options which touch upon the topics covered in this study (see section 2.4 on agriculture). Some examples of actions included in the strategy are (i) capacity building and institutional coordination for climate information; (ii) information and awareness on meteorological data and agrometeorological data; (iii) crop and water management on-farm through fertilizer and chemical use against pests and diseases and (iv) sustainable agriculture and land management through conservation agriculture, soil management or agroforestry.
- **Water:** The Water and Energy Climate Resilience Strategy covers different water-related areas such as (i) irrigated agriculture, (ii) access to water, sanitation and hygiene and (iii) crosscutting responses. The balance of water demands in order to manage and allocate according to the water which is available is one of the actions to be undertaken; this activity is closely related to quality infrastructure services such as reliable measurement of water consumption and demand (see section 2.5 on water). In the crosscutting area, activities such as data systems for decision-support including rainfall, temperature, river flows, groundwater availability and recharge data represent a strategic priority (GGGI 2017).

### Multilateral and bilateral cooperation activities

German development partners in Ethiopia are particularly engaged in the education, agriculture and natural resource management sectors. They do not focus on climate change projects yet. Altogether, climate change-related projects are mainly being implemented by the multilateral cooperation (UNDP and the World Bank).

### Multilateral cooperation

*United Nations Development Programme (UNDP):* UNDP's key interventions in Ethiopia fall under three programme pillars: growth and poverty reduction, climate change and environmental vulnerability as well as governance (UNDP 2017).

*World Bank Group (WBG):* the World Bank's work in Ethiopia focusses on two principal pillars. On the one hand, they aim to support Ethiopia in achieving a stable macroeconomic environment through increasing agricultural productivity and marketing. On the other hand, the World Bank wants to support the social dimension which includes enhancing the resilience of vulnerable households to food insecurity and resilience to climate change, among other aspects (World Bank 2017).

### Bilateral cooperation

*German Federal Ministry for Economic Cooperation and Development (BMZ):* The German bilateral engagement in Ethiopia, mainly financed by the BMZ, does not focus on climate change related-projects. Agriculture and food security are emphasized as important issues; energy topics are not a priority. Since 2014, development cooperation between Ethiopia and Germany has focussed on the following areas: education, food security and agriculture, and environmental policy, protection and conservation of natural resources and biodiversity (BMZ 2017).

*German Society for International Cooperation (GIZ):* In line with the Ethiopian Government's objectives, German development cooperation currently focusses on two priority areas: labour-market-oriented education and training and sustainable land management. In addition, a further priority area for conserving biodiversity was agreed upon at the Ethiopian-German government negotiations in 2014. The agricultural sector actually receives approximately 30 % of GIZ funding volume in Ethiopia. Quality infrastructure is addressed in several projects of GIZ in Ethiopia:

- “Establishing Binding Nationwide Standards for Measurement and the Quality of Industrial Products” focusses on standardization for sustainable infrastructure;
- “Promotion of wild coffee and honey as sustainable forest products” fosters the development of product certification processes and business relationships, while promoting value addition and quality improvements;
- “Contributing to sustainable agricultural productivity” includes the establishment of a quality system for producing seeds and certifying varieties to support rural development. (GIZ 2017).

*German Development Bank (KfW):* the German Development Bank supports Ethiopia in the following three sectors: education, biodiversity and food security and agriculture (sustainable land management and drought resilience) (KfW 2017).

## 3. Analysis of thematic focus areas

### Renewable energies and energy efficiency

In Ethiopia, traditional energy sources (such as fuel wood, crop/animal waste and human/animal power) represent the principal sources of energy due to the majority of its population living in rural areas. Only 5 % of energy supply comes from electricity, the majority of which is generated with hydropower. Energy potentials of the country are prioritized in order of importance as follows: hydroelectric power, geothermal energy, wind and solar power. Ethiopia aspires to become a regional power exporter and green energy hub for Eastern Africa. In the Climate Resilient Green Economy strategy finalized by the government in 2011, some energy supply initiatives to build a green economy were highlighted. The exploitation of hydropower and advanced rural cooking technologies were some of the proposed initiatives. The strategy foresees an increase of up to 25GW in generation potential by 2030. Hydropower would contribute 22GW, geothermal energy 1GW and wind energy 2GW.

All in all, solar energy does not play a predominate role in the Ethiopian energy sector and in the political agenda, even though further decentralized off-grid solar energy supply will be promoted under the second Growth and

Transformation Plan (GTP II). Through the update and expansion of power transmission and distribution lines, power supply interruption problems in the country might be addressed.

For the time being, hydropower generation is of crucial importance for the Ethiopian government. However, in times of climate change, to rely only on hydropower might pose a risk. Thus, a diversification of power sources should be considered and promoted in energy-related policies and strategies.

The Climate Resilient Green Economy strategy also mentions energy efficiency topics aiming at energy efficiency investments in the electric power generation sector to reduce domestic demand by 30 % by 2030.

All in all, the government recognizes the importance of pursuing energy efficiency while at the same time promoting the expansion of renewable energy (FDRE 2016, LSE 2017).

### **Meteorology**

In Ethiopia's second Growth and Transformation Plan, meteorology development is located under the "Potable Water Supply and Irrigation Development" section. The overall objective of this sector is to achieve the supply of reliable and sustainable meteorological data to the general public, especially to mitigate natural and man-made hazards. At the same time, other meteorological objectives include the provision of world standard weather prediction and early warning services as well as the enhancement of local production of imported meteorological instruments. Ensuring synergies with relevant stakeholders and agencies is also of great importance in this context.

With regard to meteorological contribution to socio-economic development, the plan emphasizes agro-meteorological (for agriculture), hydro-meteorological (for water and energy) and bio-meteorological (for health and disease) forecasting and early warning (FDRE 2016).

Just as in Kenya and other countries, meteorology is seen as a crosscutting area and is closely interrelated with all the sectors covered in this study.

### **Water**

As mentioned above, one of the main strategic directions in Ethiopia's current Growth and Transformation Plan is "Potable Water Supply and Irrigation Development". The plan emphasizes different fundamental water services which are especially relevant for this study as quality infrastructure services are needed. Some of the main priorities within the plan include access to safe and sustainable water supply as well as the assessment of the quantity and quality of the country's water resources. For the latter, quality infrastructure services are especially important. The improvement of wastewater disposal and urban sewerage systems analysed in section 2.5 on water, are focus topics as well. Furthermore, especially relevant considering climate change, are the mitigation of floods and runoff impacts initiatives. Development interventions related to water resources planned within the period of the second Growth and Transformation Plan include water supply, irrigation and drainage development, hydropower studies, surface and groundwater studies and watershed management (FDRE 2016).

Although Ethiopia is not short of water, the water resources are not distributed evenly and therefore the country faces many challenges in providing safe water for all. In order to approach these challenges, Ethiopia's One WASH National Programme was launched in 2016. It was created by the government of Ethiopia in response to the challenges of improving water, sanitation and hygiene throughout the country (OpenWASH 2016).

### **Agriculture**

The agricultural sector constitutes the main pillar of Ethiopia's economy and plays a central role in the life and livelihood of most Ethiopians. About 12 million smallholder farming households account for an estimated 95 % of agricultural production. Furthermore, exports are almost exclusively agricultural commodities, with coffee being the most relevant industry and providing the primary source of income for many thousands of small farmers (FAO 2017).



The second Growth and Transformation Plan addresses challenges related to the supply of agricultural inputs and the utilization of agricultural technologies (pre-production and production phase). Additional input demand will result from the envisaged expansion of agricultural investment outside of smallholder agriculture. As a consequence, input supply is likely to be a major constraint for Ethiopia's agricultural sector. Therefore fertilizer, seeds and agro-mechanization input supplies are planned to be strengthened. The development of smallholder crop and pastoral agriculture will be further enhanced (production phase). As in the first Growth and Transformation Plan, natural resources conservation and management will be carried out to increase agricultural production and productivity. Some of the initiatives include the use of rain-water and water harvesting in moisture-rich areas, small scale irrigation development and soil and water conservation work in moisture stressed areas (FDRE 2016).

Altogether, Ethiopia's agricultural strategy is very growth-oriented. The agricultural sector development plan pursues, first of all, accelerated and sustained growth of agriculture within the framework of the Climate Resilient Green Economy strategy.

#### Human Health

In Ethiopia, about 80 % of diseases are attributable to preventable conditions which are related to personal and environmental hygiene, infectious diseases and malnutrition (WHO 2013). In order to face human health-related challenges, Ethiopia, in its second Growth and Transformation Plan, primarily aims at providing equitable, accessible and quality primary health service through the health extension programme. The focus is given to implement primary health care at all levels of the health delivery system. Furthermore, strategies to prevent the prevalence of diseases resulting from climate change will be designed. At the same time, the proportion of households with access to improved latrines and open defecation-free facilities will be increased in order to improve access to hygiene and environmental health (FDRE 2016).

Ethiopia faces a number of challenges, which are potentially related to quality infrastructure topics covering the human health thematic area. In regards to (i) medical laboratory infrastructure, the new master strategic plan for laboratory services is being implemented. The Ethiopian Health and Nutrition Research Institute (EHNRI) is putting in place a regional laboratory network in Eastern

Africa. Unfortunately, its efforts are being hampered by issues such as inadequate human resources, limited laboratory supply chain management and poor maintenance of laboratory and other medical equipment.

In the sub-sector (ii) medication, the improvement in the availability and access to essential medicines in the health system is being promoted. The efforts made are partially attributable to the Pharmaceuticals Fund and Supply Agency (PFSA). The Food, Medicine and Health Care Services Administration and Control Agency, has developed a number of guidance documents and model legislation and provided support to other countries in the Eastern African region (WHO 2013).

## 4. Quality infrastructure services in relevant areas

### Quality policy, regulation and important institutions

In 1987, Ethiopia created the Quality and Standards Authority, an institution responsible for the governance of the country's quality infrastructure. In 1998, it was re-established under Proclamation No. 102/1998 and further amended in 2004. Finally, in 2011, the organization was split into four independent bodies responsible for the country's metrology, standardization, conformity assessment and accreditation services (Mesfin 2011).

Each of these quality institutions is defined in a regulation by the Council of Ministers:

- Council of Ministers Regulation to provide for the establishment of the national metrology institute No. 194/2010
- Council of Ministers Regulation to provide for the establishment of the Ethiopian Standards Agency No. 193/2010
- Council of Ministers Regulation to provide for the establishment of the Ethiopian Conformity Assessment Enterprise No. 196/2010
- Council of Ministers Regulation to provide for the establishment of the Ethiopian National Accreditation Office No. 195/2010 and re-established with regulation No. 279/2012 to be in line with international best practice (Yohannes 2011, Interview 1).

Quality infrastructure status	Metrology	Standardization	Testing	Inspection and Certification	Accreditation
Renewable energy					
Energy efficiency					
Meteorology					
Agriculture					
Water					
Human health					
Quality infrastructure development status	High	Medium	Low	No information	

Table 23: Development of quality infrastructure in relevant sectors

A National Quality Infrastructure Strategy, based on which a policy is planned to be developed, exists (Interview 1).

### Metrology

Since 2011, the National Metrology Institute of Ethiopia (NMIE) incorporates the country's legal and industrial metrology structures (NMIE 2017a). Regulation No. 194/2010 declares that the government is responsible for the institution's financing. The government further appoints a General Director, a General Deputy Director and other necessary staff (Federal Democratic Republic of Ethiopia 2010).

The institute is responsible for the establishment and strengthening of the national measurement system. It offers calibration, training and consultancy services on metrology and scientific equipment (NMIE 2017b). Moreover, it gives technical support and provides measurement traceability to legal metrology (Interview 3).

The NMIE maintains the Ethiopian national measurement standards in electricity, mass, length and temperature, and has a secondary standard dosimetry laboratory (NMIE 2017c). Furthermore, the institute offers calibration services with an internationally recognized accreditation by DAkkS in several, but not all of its scopes of services:

- **Mechanical quantities:** mass, weighing instruments, pressure
- **Electrical quantities:** DC voltage, DC current, DC resistance, AC voltage, AC current
- **Chemical analysis, reference materials:** volume of liquids
- **Thermodynamic/temperature quantities:** resistance thermometers, thermocouples, liquid-in glass thermometers, direct reading thermometers, mechanical thermometers (DAkkS 2015).

Additional services in those quantities as well as in length, force, volume, density and ionization and radiation are available, but are still to be accredited (NMIE 2017 c).

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

#### *Renewable energy and energy efficiency*

The NMIE provides accredited services for AC/DC low frequency measurements and has a wide range of calibration services for electrical equipment, including energy meters, ohmmeters and insulation testers, among others. These services are important for the development of renewable energy and energy efficiency. However, important services are still missing; photometry, for determining the energy efficiency of light bulbs for example, calibration services for pyranometers to ensure accurate solar irradiance data and traceability for water flow are crucial to support climate change mitigation efforts.

### *Meteorology*

Services in the area of meteorology include calibration of mercury barometers, climatic thermometers and rain gauge survey meters. An extension of services in the areas of climatic humidity, air velocity (speed measurements) and air quality including carbon emission measurements in chemical metrology are planned (Interview 3).

### *Agriculture*

Existing metrological services for mass, temperature and moisture are important for the agricultural sector. Additional measurements, such as humidity, which gain importance considering the effects of climate change, could be developed to strengthen the sector.

### *Water*

For water, accredited services for volume of liquids and additional services for hydrometers and pressure measurement in hydraulic applications are available. Currently, no services for water flow measurements are offered by the NMIE. The establishment of traceability in this area is very relevant in the context of climate change, as accurate information about water flow is a basis for drinking water distribution, water for agricultural use and hydropower development. It was also mentioned that an extension of services to cater for wastewater quality analysis is needed.

### *Human health*

Accredited metrology services for temperature, mass and pressure exist and are important for the health sector of the country. They will be increasingly important in times of climate change. The services for micro-volumes (e.g. pipettes) and density measuring instruments could be further improved to better fulfil the demand of the sector. An additional service line of the NMIE is the maintenance of scientific equipment, related training and consultancy. Institutions which use scientific instruments are supported during the establishment of their own maintenance workshops and receive training and consultancy by the NMIE which also issues certificates for trainees. Services are available for national institutions like hospitals, research institutes, higher education, quality assurance laboratories and scientific service rendering organizations and include maintenance of the following equipment:

- **Medical equipment:** electrosurgical unit, defibrillator, ECG/EKG, anaesthesia machine, fetal monitor
- **Nuclear and imaging equipment:** X-ray, CT-scan, ultrasound

- **Electro-mechanical equipment:** centrifuge, autoclave, incubator, water bath, washing machine
- **Measurement and analysis equipment:** spectrophotometer, chemistry analyser, moisture tester, digital balance
- **Scientific and medical equipment:** medical or scientific equipment installation, commissioning and maintenance (NMIE 2017d).

The NMIE collaborates with other African countries in the Intra-Africa Metrology System (AFRIMETS) (AFRIMETS 2017). It is not yet a member of international associations like the BIPM (BIPM 2017) or the International Organization for Legal Metrology (OIML) (OIML 2017).

### **Secondary calibration laboratory**

The Quality Management Centre-Calibration and Testing Laboratory Institute of the Metals and Engineering Corporation offers electrical and pressure calibration services, which were accredited by the Ethiopia National Accreditation Office (ENAO) in 2016 (ENAO 2016).

### **Standardization**

The Ethiopian Standards Agency (ESA) was established in 2010 as a non-profit government body under the Ministry of Science and Technology. Currently, it employs 136 fix staff members. ESA's tasks include the development and sales of Ethiopian standards. Furthermore, it provides information, training and technical support on standard implementation and creates public awareness about the importance of standards (ISO 2017). Standardization work in Ethiopia is focussed on the following governmental priority sectors: construction and civil engineering, electro-mechanics, food and agriculture, environment (including health and safety), textile and leather, chemical standards, basic and general standards (Interview 2).

ESA's Standards Council controls national standard development and policy-making activities. It consists of members which have been appointed by the government and which come from various organizations (ISO 2017). Jointly with the Technical Committees, which consist of experts from relevant sectors like industry, government institutions, academia, standard users, professional associations, public sector and regulatory bodies, the Standards Council develops Ethiopian standards (ESA 2017). There are currently 101 Technical Committees and over 10,000 standards have been developed to date (Interview 2).

Industrial actors are increasingly interested in participating in the standard development processes and demand for specific standards from the industries is increasing. In some cases, industry actors gather funding to enable ESA to work on the necessary standards when the yearly government budget is already allocated without the topic of interest being included (Interview 2).

With regards to the thematic areas considered in this study, the following information is of interest:

- Standards for *energy efficiency* and *renewable energy* are developed as part of the electro-mechanical priority area defined by the government, as well as under the category of environment, health and safety. Several ISO standards for refrigeration technology have been adopted. For renewable energies, next to hydropower also wind and solar energy are of interest. Standards for hydraulic and solar energy engineering are available (ESA 2015).
- For *agricultural* production and food, several Technical Committees work on specific topics (e.g. fruit and vegetables, fertilizers, seeds, etc.) (ESA 2015). In 2016, a strong focus was put on standards for seed quality and agricultural machinery (ESA 2016).
- *Water* is also considered under the focus area food and agriculture and a specialized Technical Committee is responsible for standards related to water quality (Interview 2). In 2016, a standard for hydrometry for water level measuring devices was approved. Next to the water sector, this is also of interest for hydropower development, as the determination of water levels is crucial in the planning phase of hydropower installations (ESA 2016).
- *Health* is covered by four Technical Committees which address medical devices for transfusion, infusion and injection, commercialized essential drugs, medical care practices and medical equipment and supplies. Relevant standards are available for medical health care facilities, equipment and medicine (ESA 2015, 2016).

Challenges lie in the implementation of standards. However, as standard development is increasingly demand driven, the subsequent implementation of standards is also increasing. Additionally, the need for preliminary re-

search to gain knowledge before standards are developed and for continued research after the publication to monitor the standards' effectiveness have both been identified. A restructuring of the standardization process is planned in order to allow for preliminary as well as follow-up research (Interview 2).

ESA participates in several international organizations relevant for standard setting. It is a full member of the ISO, where it acts as participating member in 15 and as observing member in 50 Technical Committees (ISO 2017). Moreover, memberships of ESA include the International Electro-Technical Commission (IEC), the Codex Alimentarius Commission (CAC) and the ARSO (ESA 2017b). ESA further collaborates with a number of national standardization bodies around the world, including Korea, Turkey, Germany and Austria and cooperates with the Economic and Monetary Union of the European Union (EMU). In the region, Ethiopia collaborates and exchanges information with Kenya (Interview 2).

### Testing

The Ethiopian Conformity Assessment Enterprise (ECAE) is the official conformity assessment body of Ethiopia. It is supervised by the Ministry of Science and Technology. It was established as a public enterprise with an authorized capital of 543 million Ethiopian birr (approx. EUR 19.7 mio.) (Mesfin 2011). The ECAE is equipped with six specialized testing laboratories performing activities in the fields of chemical products, electrical products, mechanical products, microbiology, radiation, textiles and leather (ECAE 2017a). The chemical, mechanical, microbiology, textiles and leather laboratories were accredited by ENAO and their accreditation is due to be renewed. The electrical testing laboratory was accredited in 2016 (ENAO 2017c); the radiation laboratory is in the process of being accredited (ECAE 2017d).

Apart from ECAE, other testing laboratories also offer services in various areas and the number of testing services provided is increasing. From 2011/2012 to 2013/2014, the number of Ethiopian laboratory tests increased by 122% – from 3,488 to 7,757 (GIZ 2015). Currently, 13 testing laboratories and nine medical laboratories in Ethiopia are accredited (ENAO 2017c & e). Accredited testing services are mainly concentrated in the capital area, while laboratories in other parts of the country mostly do not have an accreditation (Interview 4).

With regards to the thematic areas considered in this study, the following information is of interest:

- For *renewable energies* and *energy efficiency* there is one accredited laboratory – the previously mentioned electrical testing laboratory of ECAE.
- The majority of accredited laboratories offers services for the *agricultural sector*. There are eight agricultural research laboratories and two food testing laboratories.
- There is currently no accredited laboratory which offers testing services for the *water* sector. (ENAO 2017c). Nevertheless, laboratory facilities offering services for the water sector do exist throughout the country (Interview 4).
- In the *health* sector, one public laboratory with a focus on food science and nutrition in relation to health is accredited.

In February 2017, an Ethiopian Laboratory Association was created (TBT Programme 2017). Any kind of laboratory can join the association and benefit, for example, through joint capacity building activities and cost sharing for reference material or training. The laboratory association works together on the technical level. However, it was mentioned that the laboratory management is not yet sufficiently involved in the activities of the association (Interview 1).

In the health sector, there are several medical laboratory associations. The Ethiopian Public Health Laboratory Association (EPHLA), founded in 2006, aims to advance and maintain a high standard of laboratory services in Ethiopia. The association also supports the national disease control and prevention efforts through improved diagnostic research and surveillance (EPHLA 2017). Similarly, the Ethiopian Medical Laboratory Association (EMLA), established through the Charity and Society Proclamation No 621.2009, envisions attaining an optimal health standard for the country. It participates in medical laboratory standard setting and supports technology transfer to promote emerging technologies. Its further objectives are to improve the evidence-based laboratory practices and to advise private sector actors regarding newly marketed and validated laboratory tests (EMLA 2017).

### Certification and inspection

With regards to certification, only two national certification bodies exist. On the one hand, ECAE covers the certification of products (ISO/IEC 17065), systems (ISO/IEC 17021, ISO 14001, ISO 22000, ISO 9001:2008) and persons (ISO/IEC 17024) (ECAE 2017b). On the other hand, the Ethiopian Chamber of Commerce and Sectoral Associations (ECCSA) and sometimes the City Chambers of Commerce and Sectoral Associations if delegated by the National Chamber issue two types of Certificates of Origin. One type of Certificate of Origin is the ordinary and specialized Certificate of Origin which is used in international trade and certifies the Ethiopian origin of a product. The second type certifies that a product satisfies certain criteria according to the rules of origin of the Common Market for Eastern and Southern Africa (COMESA) and specifies whether the product is eligible for tariff reduction or elimination within the region (ECCSA 2017).

Next to local certification bodies, international certification bodies also provide services in Ethiopia. Intertek, for example, certifies food, chemical, textile, leather, plastic, rubber, construction and electrical products (Intertek 2017). Cotecna certifies the conformity of goods and issues certificates of conformity according to Ethiopian Mandatory Standards<sup>1</sup>, which is needed to clear the shipment at Ethiopian Customs (Cotecna 2017). Bureau Veritas and SGS also represent authorized third-party inspection bodies to approve imported goods at the port of entry on their compliance with the Ethiopian Mandatory Standards list (Bureau Veritas 2013, SGS Group 2017).

Ethiopia has several inspection bodies. ECAE provides ISO/IEC 17020 accredited inspection services for the areas of pre-production, production and pre-shipment. Moreover, it carries out factory evaluations and supervises loading processes (ECAE 2017c). Accredited inspection services for agricultural products are provided by A.Y. Noble Inspection and Surveillance Service, Star Ethiopia P.L.C and Afro Star International Commercial Agency (ENAO 2017d).

<sup>1</sup> In 2013, the Ethiopian Ministry of Trade established conformity requirements for certain product categories that are being imported into Ethiopia. The following categories of products are included in the Ethiopian Mandatory Standards list: metrology and measurement equipment, environment, health protection and safety equipment, electrical products, textile and leather products, chemical products (fertilizers, detergents, cosmetics), food products, paper, rubber and plastic products, construction material, solar equipment (Cotecna 2017).

In the thematic areas considered in this study, the following information on certification and inspection services in Ethiopia is relevant:

- Ethiopian Mandatory Standards exist for all thematic areas which require certification (e. g. food products, fertilizers, drinking water, protection and safety equipment and solar equipment) (Cotecna 2016).
- Most certification services and accredited inspection services are available for the agricultural sector.

### Accreditation

ENAO was re-established as an independent body in 2012 and is responsible for accreditation in Ethiopia. The organization is placed under the Ministry of Science and Technology and receives government funding to finance its activities. Additionally, some specific activities are funded by donors. Revenues created through accreditation services are collected by the national treasury. Currently, the organization employs 35 internal staff members and 98 external assessors. It is planned to increase these figures (Interview 1).

Accreditation services are available for testing and calibration laboratories (including medical testing), inspection and certification bodies (including product, system and personnel certification). In total, accreditation is available for 52 scopes for laboratories and inspection schemes.

At the moment, one calibration laboratory and 13 testing laboratories, as well as nine medical laboratories have a valid accreditation by ENAO (ENAO 2017a-e). Some of the laboratories have an accreditation for several scopes, resulting in a total of 26 accreditations for testing laboratories and 20 accreditations for medical laboratories. Moreover, four inspection bodies have been accredited (Interview 1).

It is a priority for ENAO to raise awareness among industry actors and create more demand for accreditation services. To achieve this, the organization brings together conformity assessment bodies and industry actors and enables dialogue to ensure conformity assessment services are developed where they are most needed and to encourage industry actors to use existing services. In this way, accreditation becomes more feasible for the service providers (Interview 1).

In the context of climate change, demand for energy certification is rising. ENAO wants to support certification bodies in meeting this demand and is considering introducing accreditation services for greenhouse gas validation and verification bodies according to ISO14065 (Interview 1).

The young and fast-developing organization actively participates in the AFRAC, which it currently chairs. It is an ILAC associate, but is expecting to sign Mutual Recognition Arrangements and become a full member shortly (Interview 1). Until then, some Ethiopian conformity assessment bodies use the services of the South African National Accreditation System (SANAS) for internationally recognized accreditation.

ENAO is involved in a number of bilateral collaborations, including, for example, the training of assessors and study visits from other Sub-Saharan African countries, like Nigeria and Ivory Coast. Strong links have been established with the National Accreditation Bodies of Turkey, Egypt and Kenya (Interview 1).

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 Interview 2: Endalew Mekonen, ESA Director  
 Interview 3: Abdu Abagibe, NMIE Director  
 Interview 4: Sandro Santilli, Co-founder  
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