Ethiopian-Danish Energy Cooperation

# Review of Ethiopian Energy Efficiency Policy

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# Content

# 1 Executive summary

Energy efficiency (EE) is an important issue for any country or industry that is aiming to embrace sustainable development goals and to maximise the benefits from energy resource consumption. At national level, more can be done with a given amount of energy resource. At industry or consumer level, energy efficiency measures, even if entailing initial higher costs, can lead to economic savings over longer periods due to lower energy bills. Furthermore, realisation of an amount of energy efficiency is often faster than achieving the same amount of energy via energy production technology.

In the Ethiopian context, projected rapid economic growth from an existing low level of development means that there is an opportunity for specifying energy efficient equipment and infrastructure already when new production capacity is designed and constructed, without needing to wait for a gradual replacement of existing older and less efficient products and infrastructure.

However, there are a number of potential barriers to implementing EE in Ethiopia. Horizontal barriers include: (i) the general lack of awareness of the concept of EE amongst the Ethiopian population, including industry leaders; (ii) a limited or non-existent domestic market for many electrical appliances and products; (iii) difficulties with accessing foreign currency for import of energy efficient products, coupled with a very weak exchange rate for the national currency, and (iv) very low electricity tariffs that reduce returns on any investment in energy EE.

Based on these circumstances, the objective of the assignment has been defined as delivering a review of Ethiopian EE policy with recommendations that are adapted to the country's current situation and resources. Furthermore, even though EE is relevant in all sectors, the objective of this task is to focus on EE in relation to electricity demand in appliances, buildings, and industry.

This report provides an overview of the current situation in Ethiopia, including a summary of Ethiopian legislation and governmental bodies most relevant to the implementation of EE. Other EE related initiatives employed internationally, especially in Africa, are reviewed and help shape potential recommendations for Ethiopia. In order to understand the Ethiopian perspective better, a series of interviews with relevant experts and Government representatives were conducted and the main information gained from these interviews has been used throughout the report. The review team has then made an analysis of impact, drivers and barriers and the EE potential in selected areas followed by recommendations of actions on short and medium term.

The recommended approach to energy efficiency is to focus on initiatives that can be implemented in the short term with a dual aim: to achieve experiences for further development of energy efficiency activities; and to have showcases for policy makers and target groups to demonstrate that it is possible to get results.

The initiatives include a mix of voluntary and mandatory measures including legislation; market initiatives for suppliers and retailers; technical measures; and awareness and training towards all target groups and involved parties.

The industry and the household sectors will be the main sectors to target both in the short and longer term because these two sectors are responsible for about 80% of the total national electricity consumption. Activities here should be complemented with awareness and training activities. In the medium and long term, activities towards existing and new buildings should also be established. Optimisation and improvement of the electricity distribution are also important due to the ongoing electrification activities.

The review team has provided specific recommendations for selected five areas:

- Industry: Energy audits and energy management; industrial cooling; and MEPS for electric motors
- Households: Lighting and appliances

- Awareness and training: Government; industry; and households and retailers
- Buildings: Energy audits and energy management; and building certification scheme for new constructions
- Electricity distribution: Distribution transformers; and security of electricity supply

# 2 Background and context

## 2.1 Background for review and objective

Ethiopia has a number of policies to promote energy efficiency (EE). These consist of minimum efficiency standards and training of energy auditors for industrial end-users. Activities managed by the regulator, the Petroleum and Energy Authority (PEA), include:

- Energy efficiency awareness campaigns
- Energy auditor and manager training
- Energy audits and voluntary agreements for industry
- Lighting standards and labelling
- Efficiency labelling program
- Electric motor standards
- Injera mitad standards
- Electric cook stove standards
- Efficient injera mitad manufacture
- Efficient welding systems

Energy Efficiency is often the cheapest source of clean energy and can therefore be effective in reducing the consumption of wood fuel, as well as dampening the growth of electricity demand. The demand for electricity in Ethiopia is low (100 kWh/capita) but is increasing rapidly (more than 10% p.a.). In ten years, the electricity demand will be dominated by equipment that does not exist today. The role of EE policies such as minimum standards could be important in reducing the growth in demand for electricity.

However, there are many challenges in Ethiopia:

- Importing hardware is complicated and expensive. The access to hard currency is very limited.
- The institutional strength of the implementing bodies is limited (with regards to funding, staff etc.).
- End-users may prioritise low investment cost due to their economic situation.
- The supply-chain for efficient equipment may be under-developed.
- Electricity tariffs are not cost reflective. However, the tariff has increased during the last four years. A seven step progressive tariff results in very low costs to households with a low demand. The lowest interval is below 50 kWh/month and the highest starts at 500 kWh/month. The tariff goes from 0.273 to 2.481 Birr/kWh (0.0049-0.045 USD/kWh).

This project will deliver a review of Ethiopian EE policy, with recommendations that are adapted to the country's current situation and resources. Although EE is relevant in all sectors, the objective of this task is to focus on EE in relation to electricity demand in appliances, buildings and industry.

The study was based on a desk review of documents and interviews with representatives from relevant institutions. Originally, the review should have included a team mission to Ethiopia of a week's duration, however, due to issues with obtaining entry visas, it was not possible to carry out the mission. Instead, a limited number of online interviews were carried out (see Table 1). While an interview with the Ethiopian Standards Agency (ESA) was sought, it was not possible to get a response from ESA within the timeline of the study.

*Table 1. List of interviewees*

| Organisation | Person | Title |
|---|---|---|
| Ministry of Water and Energy (MoWE) | Mr Mesfin Dabi Seboka | Head of the Power Development and Regional Integration Desk |
| Ethiopian Petroleum and Energy Authority (PEA) | Mr Zewge Worku | Director of the Energy Efficiency and Conservation Directorate |
| Ethiopian Electricity Utility (EEU) | Mr Abay Admasu | Energy Management Director |
| Yomener Energy Auditing and Engineering PLC | Mr Yemanebrhan Kiros | Senior Energy Consultant and Energy Auditor |
| Self-employed | Mr Wondwossen Sintayehu | Advisor on energy efficiency schemes, campaigns and programmes |
| Citizen, mother of three adults living in a household of six people in the suburbs of Addis Ababa | Anonymous | |

The team focused mainly on recommendations that could be implemented in the short and medium term in order to achieve results that could feed into broader EE policy and legislative measures. Furthermore, the team also focused on what would be achievable in the Ethiopian context when taking into account the current social, political and economic situation in the country.

In terms of scope, particular attention was paid to energy efficiency policy of energy-consuming appliances and products (especially lighting, electric motors and cooking products) and to potential measures relating to buildings and industrial processes. Inspiration from good examples in other countries was considered wherever especially relevant.

## 2.2 Ethiopian background and context

### 2.2.1 Population and economy

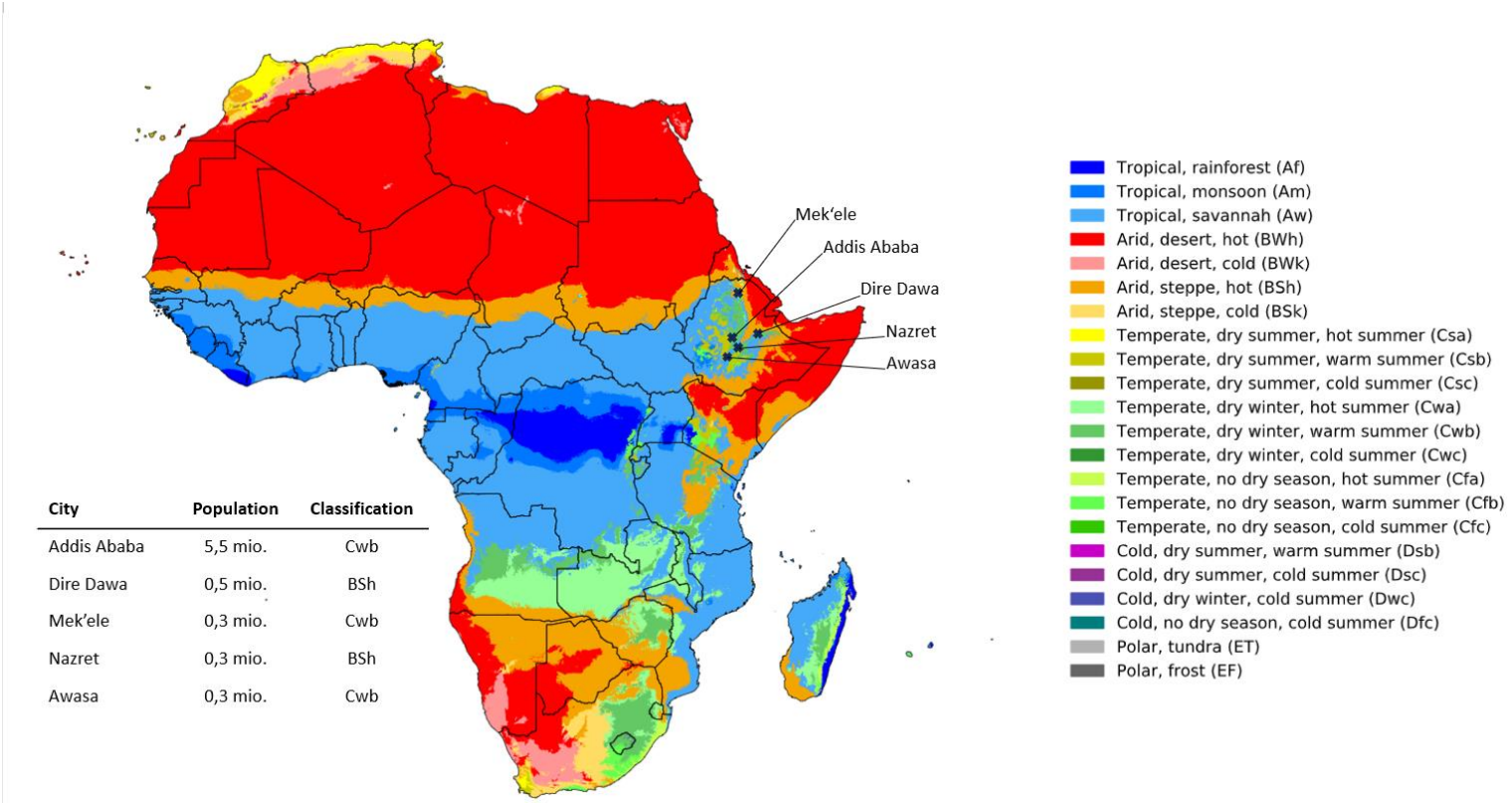
Ethiopia has a growing population that is already around 110 to 120 million people, the vast majority of whom (>80%) live in rural areas. About 7 million live in the five largest cities including the capital Addis Ababa with 5.5 million inhabitants.

In the last 10 to 15 years, Ethiopia has been one of the fastest growing economies in the world. The average annual GDP growth rate was 9.2% during the period of 2010 to 2020[1]. In terms of national energy resources and current labour costs, Ethiopia has a great potential to attract foreign investment, become an internationally competitive producer and to become a genuine middle-income country with a sustainable and wealth-generating economy.

### 2.2.2 Geography and climate

Ethiopia is located in an area with a varied climate with both temperate areas, arid desert and steppes, and tropical savannah. The urban population of Ethiopia is centred in Addis Ababa, with the other cities being both smaller and similar to each other in size. Looking at Addis Ababa and four of the other major cities, it can be seen, that Addis Ababa, Mek'ele and Awasa are located in temperate climates with two rainy seasons (a small one in February, and a larger and relatively cold one in July-September), whereas Dire Dawa and Nazret are located in a climate classified as hot arid steppes.

[1] Ethiopian Energy Outlook, 2022.




| City | Population | Classification |
|---|---|---|
| Addis Ababa | 5,5 mio. | Cwb |
| Dire Dawa | 0,5 mio. | BSh |
| Mek'ele | 0,3 mio. | Cwb |
| Nazret | 0,3 mio. | BSh |
| Awasa | 0,3 mio. | Cwb |

*Figure 1. Köppen-Geiger climate classification map with the five largest Ethiopian cities highlighted. Based on: Beck et al. (2018) 'Present and future Köppen-Geiger climate classification maps at 1-km resolution.*

### 2.2.3 Primary energy consumption

The estimated 2018 national energy demand in Ethiopia is shown below, in terms of use type and energy source used. Note that household electricity access is much higher in urban environments (96% in 2019) than in rural areas (34% in 2019)[2], which naturally is an important determining factor for energy use.

[2] See entry on "Energy" for Ethiopia in "The World Factbook": https://www.cia.gov/the-world-factbook/countries/ethiopia/#energy

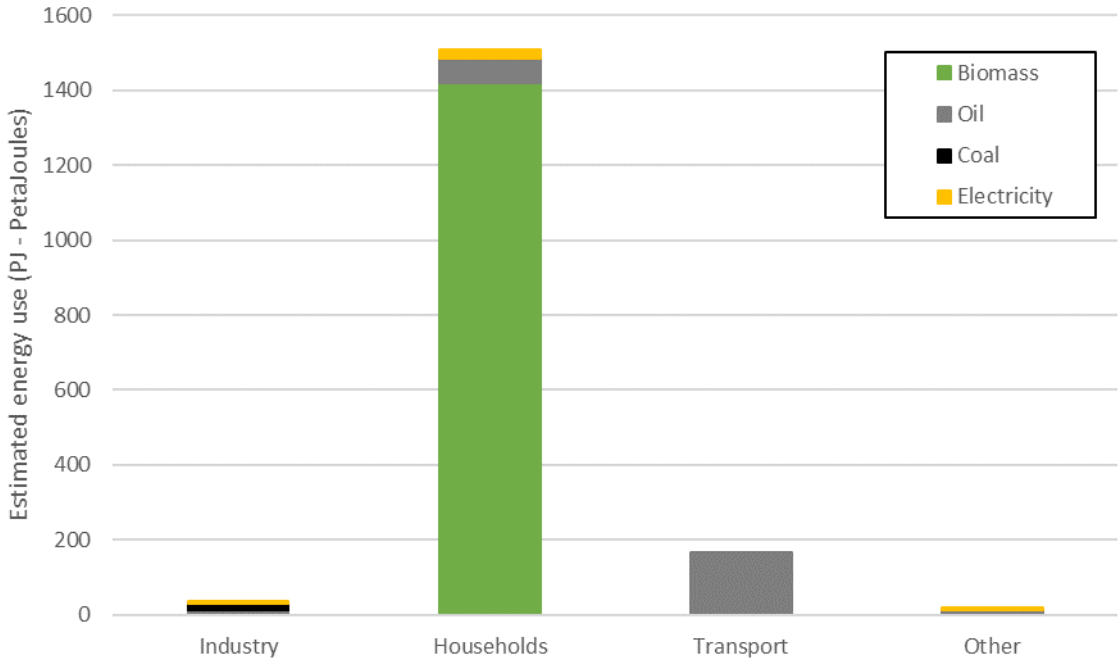



*Figure 2. Total final energy consumption in Ethiopia in 2017/18. Own chart, data taken from Ethiopian energy outlook, 2022.*

Ethiopian primary energy consumption is currently dominated by the use of biomass in households. Some 90% of biomass consumption in households is for cooking, and the majority of this (ca. 50-75%) is for the preparation of injera (typical Ethiopian flatbread) in mitad style stoves (flatbread maker) [Jones et al., 2017][3]. Biomass stove cooking is extremely inefficient, converting only around 5 to 10% of the calorific value of the biomass into useful heat. While a number of variations of the biomass stoves have been developed in Ethiopia, some being more efficient than others [Tadesse, 2020][4], the least efficient and most rudimentary "three stone" stoves continue to be the most common in many rural areas [Dagnew Tessema and Ayalew Mekonnen, 2021][5].

While the current situation of biomass combustion for heat production and renewable sources for electricity generation is favourable in terms of self-sufficiency and in terms of direct emissions of greenhouse gas (GHG) emissions, there are important drawbacks, especially in the context of a rapidly growing economy.

For example, the unsustainable harvesting of biomass can result in land use change GHG emissions and enhance soil erosion. There is a high pressure on natural resources (ca. 50% exploitation). The labour-intensive gathering of biomass at household level deprives individuals (predominantly women and children) of time that could otherwise be used for education or income-generating activities [Lewis and Pattanayak, 2012][6]. The sub-optimal combustion in rudimentary stoves can result in harmful emissions of particulate matter, nitrogen oxides and carbon monoxide in homes [Ezzati and Kammen, 2001][7].

[3] Jones R., Carel Diehl J., Simons L., and Verwaal M., 2017. The development of an energy efficient electric mitad for baking injeras in Ethiopia. Proceedings of the 25th Domestic Use of Energy Conference.
[4] Tadesse M., 2020. The developmental patterns of Injera baking stoves: review on the efficiency, and energy consumption in Ethiopia. SSRG International Journal of Mechanical Engineering, Vol. 7(1), p.7-16.
[5] Tessema T.D. and Mekonnen B.A., 2021. Assessment of improved biomass cook stoves in Ethiopia: utilization practices and adoption factors; the case of Merawi, Kolela district. Academy of Entrepreneurship Journal, Vol. 27(S2).
[6] Lewis J.J. and Pattanayak S.K., 2012. Who adopts improved fuels and cookstoves. Environmental Health Perspectives, 120(5), p.637-645. DOI: 10.1289/ehp.1104194
[7] Ezzat M. and Kammen D.M., 2001. Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure response study. The Lancet. Vol. 358, Issue 9282, p.619-624. DOI: https://doi.org/10.1016/S0140-6736(01)05777-4

After biomass, oil is the second highest primary energy consumption source. It is important for industrial generators, especially if electricity supply is unstable and for transportation. However, oil imports cost 20% of GDP. There are plans to develop natural gas fields. Part of this might be used for industrial purposes substituting oil imports. Electrification of transportation with electric vehicles have already started in Addis Ababa.

The third highest primary energy consumption source is renewable electricity and mainly hydropower. Finally, there is also a smaller amount of coal consumption.

### 2.2.4 The electricity sector to date

Electricity only accounted for around 2.4% of total national primary energy consumption in 2018, but is coming almost entirely from renewable resources (ca. 96% hydropower, 3% wind and 1% from other sources) [Ethiopian Energy Outlook, 2022]. The main cost elements of electricity production in Ethiopia are presented in a broader African context in the figure below.

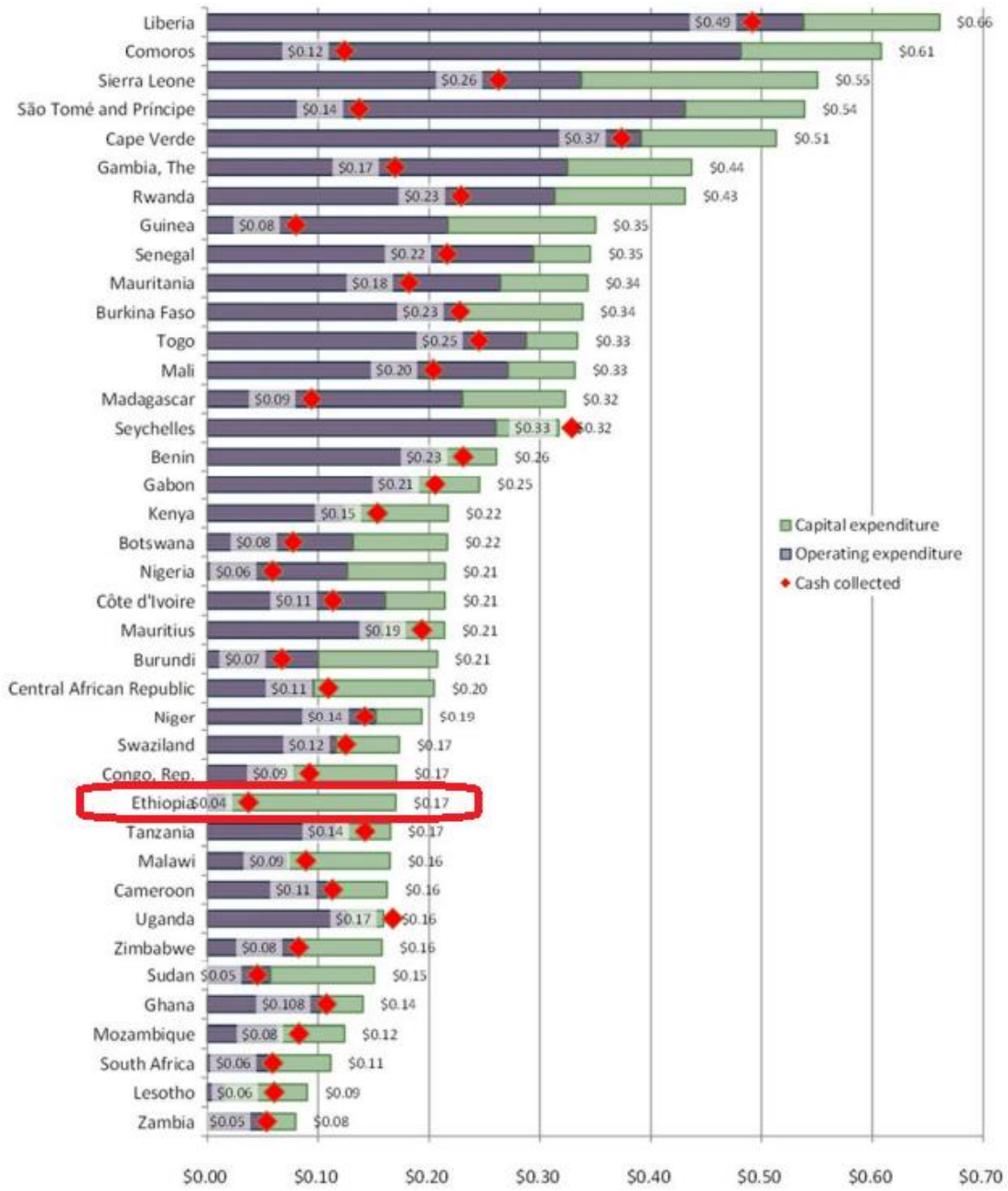



*Figure 3. Comparison of electricity costs with cash collected in 2014 USD per kWh billed. Source: Trimble et al., 2016. More recent figures were not available, however, it is expected that the relations between capex and opex and the variety of tariffs are basically unchanged since then.*

The data in Figure 3 clearly show that:

- The unit cost of electricity production ($0.17/kWh, 2014) in Ethiopia is relatively cheap in the African context.
- Ethiopian electricity is much more capex intensive than other African countries, not only in terms of unit cost (ca. $0.15 capex/kWh) but especially in terms of capex as a % of total electricity costs (ca. 88%).
- The vast majority of African countries failed, to one extent or another, to generate enough revenue to cover the costs of electricity production.
- Ethiopia has the largest % deficit between the revenue collected and the actual cost of electricity production ($0.04/kWh collected and $0.17/kWh production cost means a 76% deficit). Even though tariffs have been increased since 2014, they are still far from cost-reflective.

The high capex of Ethiopian electricity is due to the high and capital-intensive infrastructure costs typical of hydropower projects and other renewable energy projects. Estimated average electricity prices in Ethiopia have not been cost reflective for a number of years. Unless remedied, non-cost reflective electricity will present a continual fiscal burden that would only be increased further as efforts to increase access to electricity for Ethiopian citizens and businesses progress. Furthermore, unrealistically cheap electricity undermines any economic incentives to replace less efficient equipment with more efficient alternatives.

Unit prices for electricity in Ethiopian are split into a total of seven tiers or tariffs, the cheapest one being for the smallest residential consumers, who also tend to be the poorest customers, see Table 2. As consumption rates increase, so too does the unit price of electricity. Due to concerns highlighted in the paragraph above, and in order to make the price of electricity more cost-reflective, the Ethiopian government has increased the price of electricity in the last 5 years as shown below. However, high inflation has largely neutralised the increase and therefore the price increases has only resulted in approximately 10% increase in inflation-corrected prices, where a factor 3-4 increase is needed if tariffs should be cost-reflective.

*Table 2. Evolution of unit price of electricity (Birr / kWh) for residential tariffs in Ethiopia*

| Residential tariffs (Share of house-holds in each block) | Price* as of Dec. 2018 onwards) | Price* as of Dec. 2019 onwards (% increase) | Price* as of Dec. 2020 onwards (% increase) | Price* as of Dec. 2021 onwards (% increase) | Overall increase since Dec. 2018 | Overall increase since Dec. 2018 (constant prices**) |
|---|---|---|---|---|---|---|
| Block 1 (up to 50 kWh per month – 31% households) | 0.2730 | 0.2730 (0%) | 0.2730 (0%) | 0.2730 (0%) | 0% | -77% |
| Block 2 (up to 100 kWh per month – 16% households) | 0.4591 | 0.5617 (22%) | 0.6644 (18%) | 0.7670 (15%) | 67% | -10% |
| Block 3 (up to 200 kWh per month – 23% households) | 0.7807 | 1.0622 (36%) | 1.3436 (26%) | 1.6250 (21%) | 108% | +31% |
| Block 4 (up to 300 kWh per month – 12% of households) | 0.9125 | 1.2750 (40%) | 1.6375 (28%) | 2.0000 (22%) | 119% | +42% |
| Block 5 (up to 400 kWh per month – 6% of households) | 0.9750 | 1.3833 (42%) | 1.7917 (30%) | 2.2000 (22%) | 126% | +49% |
| Block 6 (up to 500 kWh per month – 3% households) | 1.0423 | 1.4965 (44%) | 1.9508 (30%) | 2.4050 (23%) | 131% | +54% |
| Block 7 (above 500 kWh per | 1.1410 | 1.5877 (39%) | 2.0343 (28%) | 2.4810 (22%) | 117% | +40% |

| | | | | | | |
|---|---|---|---|---|---|---|
| month – 9% of households) | | | | | | |

*Source: Ethiopian Electric Utility website*

**Prices are given in Birr/kWh. **Inflation was estimated to be 15.8% in 2019, 20.3% in 2020 and 26.8% in 2020, leading to compound inflation of almost 77% between 2019 and 2022. The constant prices are inflation corrected.*

The goal is to arrive at a cost reflective tariff level. The World Bank provides technical assistance to the EEU on the tariff setting. New tariffs may be announced in late 2023.

Countries with low energy tariffs typically have difficulties in increasing them because of complaints from all economic sectors of the society. This may be partly alleviated by financial compensation, which are not related to the size of the energy consumption, and by targeted campaigns for energy efficiency e.g. regarding replacement of less costly products such as lighting for more efficient types and more consideration on long-term costs when buying more expensive but more efficient energy-consuming consumer goods.

A survey showed that very few citizens actually considered replacing appliances with more energy efficient types as a means to alleviate tariff increases. In a survey of 1400 households reported by Hassen et al., (2021)[8], the adoptive actions taken by Ethiopian residents after increases in electricity tariffs were as follows:

- Reduced frequency of baking and cooking: 31%
- Turning off light bulbs and other devices when not in use: 27%
- No new actions: 23%
- Switching to other fuel sources, such as biomass: 11%
- Adoption of energy efficient appliances: 4%
- Reducing the number of light bulbs: 3%

While the top two adoptive behaviours are positive with regards to energy conservation habits, there is a significantly bigger shift to biomass fuels (11%) than to energy efficient appliances (4%). Consequently, care needs to be taken with the tariff increases so that they do not provoke an undesirable shift back towards the use of biomass, and the problems that brings, if biomass is perceived as being more convenient than electricity.

### 2.2.5 Future development of the electricity sector

A scenario run to 2030 by Mondal et al., (2018)[9], the following growth in electricity demand by sector is predicted in a case where all households end up with an electricity supply:

[8] Hassen et al., 2021. Policy Brief: How to promote energy efficiency and energy conservation in Ethiopia. Energy and Economic Growth, Applied Research Programme. doi:10.5281/zenodo.5655487

[9] Mondal M.A.H., Bryan E., Ringler C., Mekonnen D. and Rosegrant M., 2018. Ethiopian energy status and demand scenarios: Prospects to improve energy efficiency and mitigate GHG emissions. Energy Vol. 149, p.161-172. https://doi.org/10.1016/j.energy.2018.02.067

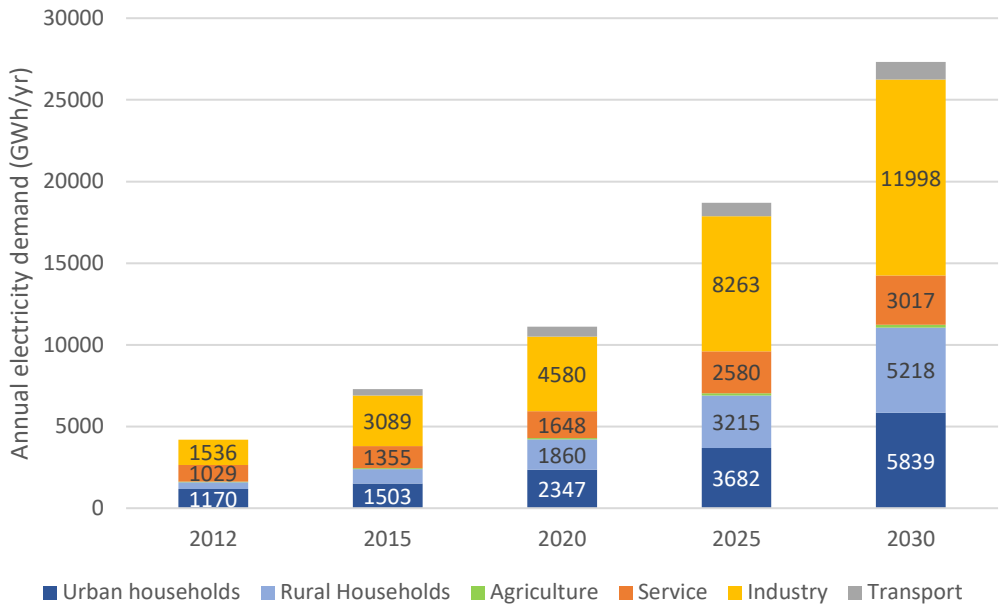



*Figure 4. Sector-wise electricity demand under the universal electrification scenario. Source: Mondal et al., 2018.*

As can be seen above, the two largest sources of increase in electricity demand are industry and households. Looking between 2020 and 2030:

- Industrial demand expected to increase 162% over 10 years
- Urban household demand expected to increase 149% over 10 years
- Rural household demand expected to increase 180% over 10 years

The continued development of energy resources and infrastructure is crucial to fuelling economic growth in the energy-demanding industrial, manufacturing and construction sectors and to create jobs in urban areas, where unemployment rates are high.[10]

Apart from industrial activities, other pressures on electricity demand are the growing population and the currently very low per capita electricity consumption (around 122 kWh/person/year compared to the African average of 500 kWh/person/year in 2021)[11] and low electrification rate. These demands can be expected to increase due to the following factors:

- Increase in total population from around 118 million in 2021[12] to 134-143 million in 2030.
- Increase in per capita electricity consumption from the current low levels
- New connections averaged 220,000 per year between 2017 and 2022[13].
- A shift from biomass-based to electricity-based appliances, especially for cookers and water heaters in urban households with Tier 5 reliability (highest level) of electricity supply (note: only about 4.5% of Ethiopian households met Tier 5 electricity supply standards in 2017, but this will only increase)[14].

Future growth in electricity demand does not need to compromise sustainability goals or increase reliance on imported fuel or electricity. According to Hailu and Kumsa (2020)[15], Ethiopia has significant potential to

[10] Ethiopia 2030: The Pathway to Prosperity. Ten Years Perspective Development Plan (2021-2030).
[11] Ritchie H, Roser M. Access to energy. Our World in Data. Accessed online March 2023: https://ourworldindata.org/energy-production-consumption#per-capita-which-countries-generate-the-most-electricity
[12] See UN Department of Economic and Social Affairs – Population Division data: https://population.un.org/wpp/Download/Standard/Population/
[13] Ethiopian Energy Outlook, 2022 (see pages 27-28).
[14] See Figures ES3, 2.1, 2.5
[15] Hailu A.D. and Kumsa D.K., 2020. Ethiopia renewable energy potentials and current state. AIMS Energy, 9(1), P.1-14. Doi: 10.3934/ENERGY.2021001

meet future electricity needs via a diversified range of cost-effective renewable energy sources in addition to hydropower, especially via solar power, but also wind and geothermal.

Apart from being able to meet growing domestic needs, Ethiopia is well-placed to act as an important exporter of electricity to its neighbouring countries – the National Electrification Plan v2.0 predicts an increase in electricity exports in terms of capacity from around 1 GW to around 5 GW between 2021 and 2030[16], however, today the value is 0.5 GW. In terms of electric energy, in the high export scenario the export is expected to increase from 1.7 TWh in 2021 to 10 TWh in 2030.

### 2.2.6 The role of energy efficiency

Improved energy efficiency will support every facet of the Ethiopian government´s ambitious drive to increase economic activity and the quality of life of its citizens, while still respecting climate concerns. Energy efficiency benefits end users, who save money, it benefits utilities by reducing peak demand and, in the Ethiopian case, it can benefit electricity export by dampening the year-on-year growth in demand. The improvement of energy efficiency is already identified as strategic priority 1.2 in Ethiopia´s Climate-Resilient Green Economy (CRGE) strategy.

Given the current and projected future scenario for Ethiopia, there is a major driver to set in place energy efficiency policies to ensure that: (i) more can be done for each GWh of electricity generated, and (ii) that the many new appliances, buildings and industrial facilities that will be purchased and built in the near future will be energy efficient to begin with. Often, energy efficient products and systems are also of higher quality and have a lower Total Cost of Ownership (TCO), taking all costs over lifetime into account.

In terms of appliances and products, energy efficiency can be applied via mandatory minimum energy performance standards (MEPS) that all products must comply with and/or via energy labels, that indicate the energy efficiency of the product. Minimum efficiency standards are often used for electric appliances, products and systems but can also be applied to fuel-based technologies.

In terms of buildings, energy performance standards are more complex to define, since energy and sustainability performance depends not only on the efficiency of heating, cooling and lighting systems, but also on the choice of construction materials, how well they are constructed and put together, as well as how the overall building architecture interacts with the surrounding environment and the climatic zone of the construction. The implementation of energy efficiency requirements for buildings is normally linked to national building codes and regulations, which tend to place requirements on the technical performance of walls, windows, doors, flooring, roofs and insulation, amongst others.

With industrial processes and productions and with larger commercial and public buildings and other locations, energy auditing by external experts is a very practical approach to identifying potential improvements in energy performance, by assessing the process as a whole and considering the potential payback periods of different actions. The development of energy management systems can help ensure that efforts remain focussed on attaining or maintaining optimal energy performance and developing in-house expertise for energy efficiency. Furthermore, minimum efficiency standards and energy labels for products and equipment are also relevant policy measures for the industrial, commercial and public sectors.

A major issue for energy efficiency is lack of awareness or rather that often other priorities are more important when purchasing energy consuming products such as price, functionality, availability, etc. Furthermore, public information on energy consumption and annual operation costs is often not available.

In section 3, we detail the Ethiopian energy efficiency policy and measures.

[16] See specifically Table 1.2 of FDRE, 2019: National Electrification Program 2.0.

## 2.3 End-use sectors

We describe in the following the household and the industry sectors and, cross-cutting to all sectors, electrical appliances.

### 2.3.1 Households

According to the data behind Figure 2, household activity in Ethiopia is responsible for 99% of national biomass fuel consumption, 58% of national electricity consumption and 4% of national oil consumption.

While primary energy consumption is dominated by the use of biomass in cookers, any shift to electrical cookers or water heaters in the future would ensure that households remain as the major electricity consuming end-use sector at national level. The potential for Ethiopian households to shift towards the use of more electrical appliances in the future depends on the security and reliability of electricity supply. This has been assessed in Ethiopian households using the multi-tier system, see Figure 5.

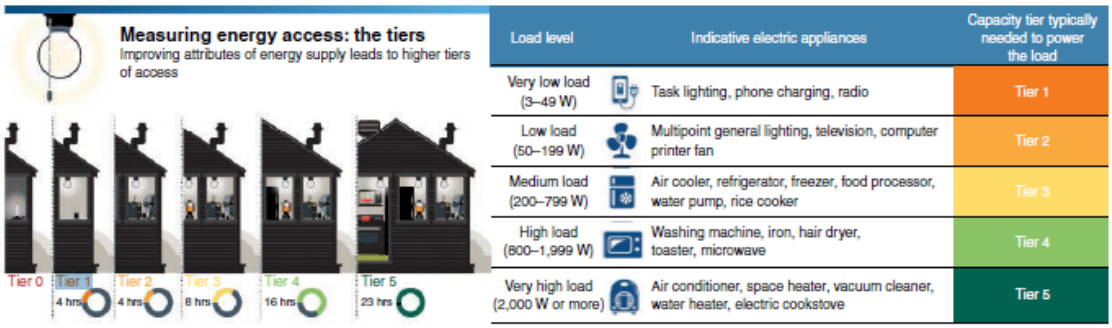



*Figure 5. Explanation of the multi-tier system for categorising household electricity supply. Source: FDRE, 2019 (NEP v.2.0).*

Apart from cooking and water heating, the other appliances that can be major consumers of electricity in households mentioned in the multi-tier system are: air conditioners, refrigerators, lighting, space heaters and, depending on access to mains water supply and wastewater discharge networks, washing machines and dishwashers.

In the Ethiopian context, a major food preparation appliance is injera mitad for preparation of flatbread and other types of bread. In cities and also in part of the countryside, it is typically an electrical appliance. In the study 'Ethiopia: eCooking market assessment'[17] it is estimated that 65% of the households in Addis Ababa use electric cooking appliances, and they find that cooking with electricity is the most economical, when excluding cooking with collected biomass.

The mitad may be used a few times a week for several hours at a time. Additionally, an electric stove is used for food preparation, food reheating and preparation of tea and coffee. Fridges are also common. The other main appliances are TV sets, often on many hours, lighting, phone chargers and rechargeable flashlights to be used during power outages. Washing machines, dishwashers and air conditioners are typically not in Ethiopian households.

[17] https://mecs.org.uk/?s=Ethiopia+eCooking+Market+Assessment

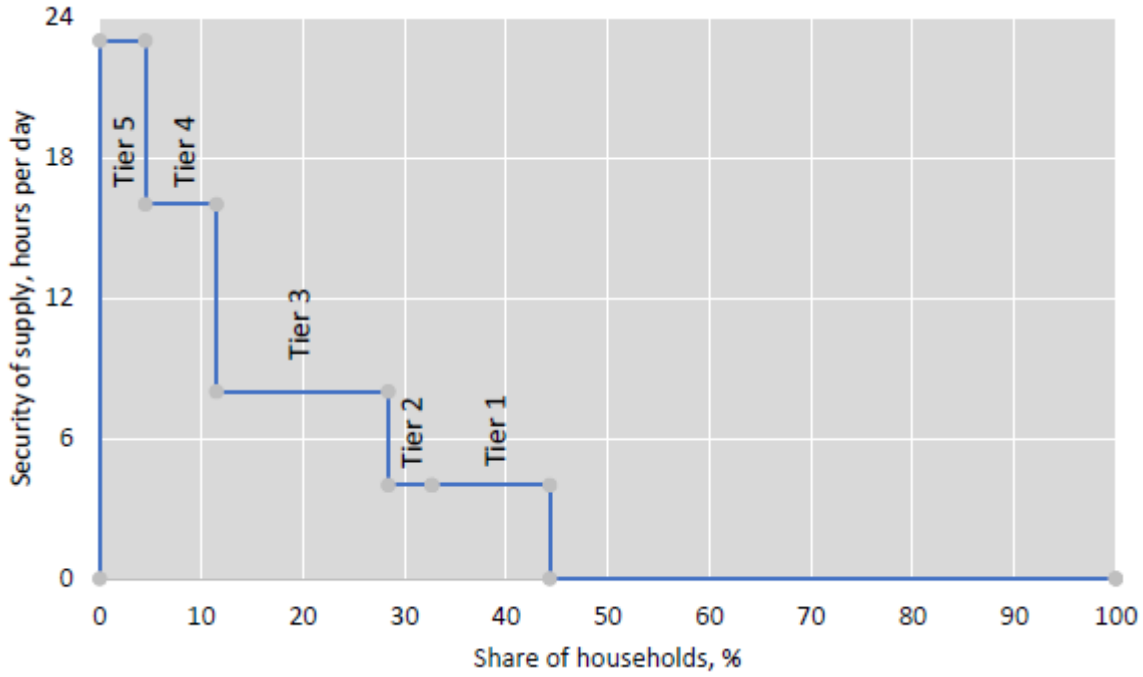



*Figure 6. Distribution of Ethiopian households by electricity supply security in 2017, according to the multi-tier framework. Source: MoWE+EEA+DEA, 2022 (Ethiopian Energy Outlook)*

An important point to bear in mind is that the national level figures mask a major distinction between households in urban areas (ca. 96% with connection to national grid) and households in rural areas (ca. 27% with access to electricity at one tier or another). Evidently, rural households are much greater in number than urban households.

Consequently, the short-term impact of energy efficiency policies will be much higher in urban households than in rural ones. Coming back to the national level, and based on the results of the survey shown above, it can be stated that energy efficiency policies in Ethiopia for electrical household appliances would:

- have a full impact in only 4% of Ethiopian households (i.e. those with Tier 5 supply),
- have a moderate impact in 24% of Ethiopian households (i.e. those with Tier 3 and 4 supplies),
- have a limited impact in 16% of Ethiopian households (i.e. those with Tier 1 and 2 supplies), and
- have zero impact in 56% of Ethiopian households (i.e. those with no electricity supply).

However, energy efficiency policies also have an important aim of tackling expected future increase in electricity consumption, i.e. when more households will move to higher Tier classes. This also correlates with processes of implementing EE policies, because it may take a time, e.g. 5-10 years before they have an impact.

The most common electrical appliance that will be used across Tiers 1 to 5 is lighting. It should be noted that previous efforts to promote energy efficient lighting resulted in the replacement of old incandescent bulbs with compact fluorescent lamps (CFLs). Today, light emitting diode (LED) lighting is generally more efficient than CFL and new initiatives to promote energy efficient lighting are justifiable.

In a 2012 report[18], a survey of 1,000 householders (presumably all urban households with a Tier 5 type of electricity supply) revealed that the main electricity consumption was split as follows:

- 42% lighting
- 18% others
- 14% entertainment (TV, radio, computer, internet etc.)

[18] Kärkkäinen et al., 2012. DSM potential and proposed actions in Ethiopia.

- 14% refrigeration
- 12% cooking

Since 2017, more than 1 million households have been connected to the electrical grid[19] and so it would be pertinent to repeat the multi-tier survey again to see how the distribution of Tier 0 (no connection) to Tier 5 has changed over these last few years, not only in terms of % of households, but in terms of absolute numbers of households. Absolute numbers of households would also permit quantitative assumptions to be made about estimated consumptions and savings potentials.

### 2.3.2 Industry

According to the data behind Figure 2, industrial activity in Ethiopia is responsible for 100% of coal consumption, 21% of electricity consumption and 7.2% of oil consumption. The main industrial sectors identified in Ethiopia in the EEA´s Energy Efficiency Framework Strategy (EEA, 2018) are, in no particular order, as follows:

- Cement production
- Metal and metal engineering
- Chemical industries
- Pharmaceutical industries
- Textile and garment production
- Leather and leather article production
- Agro-processing industries
- Micro- and small-scale enterprises

Industrial activity in Ethiopia is vital to reduce reliance on imported goods, create added value and to create jobs. Some sectors may be considered of strategic importance (e.g. the agro-processing industry for security of food supply and cement and metal production for construction of new buildings and infrastructure).

Before being able to identify the potential impact of energy efficiency policies on the industrial sector in Ethiopia, it is necessary to know the scales of these different industries at the present moment, what is the current energy performance of existing industry, what are the conclusions from energy auditing and what is industry best practice that could be mandated for any new industrial facilities.

A particularly relevant development is the ongoing plan to construct 12 or 13 industrial parks in Ethiopia. In order to attract international companies to bring their business to these parks, security of energy supply is a crucial factor. There are also major opportunities to ensure that any new manufacturing facilities are built and operated in accordance with industry best practice at international level in terms of energy and environmental performance.

[19] See page 10 of the Ethiopian Energy Outlook, 2022 (it says 330,000 new connections in 2021 and an average of 220,000 per year in the last 5 years).


*Figure 7. Locations of industrial parks planned or already built in Ethiopia. Source: https://www.ipdc.gov.et/about/*

The clustering of different industries together also offers opportunities for symbiotic relationships to be established. For example, the use of waste heat from one industry being used to dry feedstock or fuels used in another industry. Or the use of by-products (e.g. blast furnace slag from iron production) as an added-value supplementary cementitious material in cement manufacture.

### 2.3.3 Commercial sector

The commercial sector consists of smaller shops, larger hotels in main cities, shopping malls, etc.

### 2.3.4 Public sector

The public sector consists mainly of administration buildings and municipal services such as road lighting in cities, water supply and wastewater treatment.

### 2.3.5 Electrical appliances

Before understanding how any energy efficiency strategies may work for electrical appliances, it is important to identify the main appliances that are being used. Since Ethiopia does not generally manufacture electrical appliances, a great deal of information could potentially be obtained regarding imports to the country.

The Energy Efficiency Strategy published by the EEA in 2018 mentioned the following electrical appliances as being relevant, with import figures from 2005 and 2009:

- Electric ovens and cooking plates, ca. 186,000 imports in 2009
- Refrigerators, ca. 80,000 imports in 2009
- Coffee and tea making machines, ca. imports 22,000 in 2005

- Smoothing irons, ca. 21,000 imports in 2009
- Water pumps, ca. 13,000 imports in 2009
- Air conditioning units, ca. 8,000 imports in 2009
- Air compressors, ca. 3,000 imports in 2009
- AC (Alternating Current) motors, ca. 11,000 imports in 2005
- AC generators, ca. 2,000 imports in 2009

If there is no domestic production of these products, the numbers involved indicate very low ownership rates given the 110+ million population in Ethiopia. Naturally, when the figures are 14-18 years old, these are not providing the picture of today, however, updated information about imports could not be gathered. Interviews we made revealed that there is a significant informal market, where electrical goods have been imported without been registered, which may include second-hand products.

## 2.4 Ethiopian organisational setup

Based on a review of governmental legislation and websites, the roles and responsibilities of different organisations and groups are illustrated below.

### 2.4.1 Ministry of Water and Energy (MoWE)

The Ministry of Water and Energy (hereafter referred to as MoWE) covers three main sectors: (i) water supply and sanitation; (ii) water resources management), and (iii) energy. The Ministry is co-ordinating the Ethiopian Electrification Program financed by the World Bank and is currently active in a number of projects to increase electricity supply, increase access to electricity and improve the sustainability of energy supply. Land topography and water resources in Ethiopia have led to hydropower generating around 95% of the total (14 TWh) electricity produced by the Ethiopian Electric Power Corporation in 2022. The MoWE has published a water and energy strategy as part of Ethiopia´s Climate-Resilient Green Economy (CRGE). One crucial part of this strategy is of direct relevance to this project, namely “strategic priority 1.2: Improve energy efficiency”.

### 2.4.2 Ethiopian Electric Power (EEP)

Ethiopian Electric Power (hereafter referred to as EEP) was previously part of the Ethiopian Electric Power Corporation (EEPCo). Since 2013, via FDRE Regulation No. 302/2013, the EEPCo was split into the EEP and the EEU (Ethiopian Electric Utility). The EEP takes responsibility for the planning, design, construction, and maintenance of electricity generating plants connected to the grid (22 in total, mainly hydro and wind). The EEP is also responsible for the construction, installation, maintenance and leasing of all transmission lines and substations operating at 132kV or more and for the export of electricity to neighbouring countries.

### 2.4.3 Ethiopian Electric Utility (EEU)

The Ethiopian Electric Utility (EEU) was established via FDRE Regulation No. 303/2013 to play an intermediary role between the EEP and customers. This involves the bulk purchase of electricity, the management of transformer stations, medium-voltage and low-voltage transmission lines and the sale and billing to individual consumers. The EEU is structured for working in 13 regional departments, with 28 district offices and 540 service centres. The EEU is also involved in decentralised power supply projects and smaller electricity generating stations, mainly solar PV systems in islanded systems.

### 2.4.4 Petroleum & Energy Authority (PEA)

The Petroleum & Energy Authority (PEA) is a regulatory body for the petroleum and energy sector established via FDRE Proclamation 1263/2021. Their mandate includes the formulation and regulation of legal frameworks for the sector, manage the certification of relevant businesses and professionals, manage long-term and short-term EE programmes, set national targets, make strategies, create guidelines, sign agreements on EE, manage EE standards and funds, establish EE standards and labelling program, monitor wholesale and retail prices of petroleum products, and liaison with the MoWE on energy

tariff recommendations, standards for the grid and off grid and granting licenses to companies investing in electricity generation and distribution.

The PEA has also effectively taken over the previous responsibilities of the Ethiopian Energy Agency, now being the main organisation responsible for co-ordinating policies to improve, promote and regulate energy efficiency and conservation including energy labels and energy auditing.

### 2.4.5 Ethiopian Standards Agency (ESA)

The Ethiopian Standards Agency (ESA) was established via Regulation No. 193/2010 as an autonomous federal government office whose main objectives are: (i) to develop Ethiopian standards; (ii) establish a system to assess compliance with standards; (iii) to facilitate technology transfer in Ethiopia via the use of standards, and (iv) to develop national standards for local products and services to make them competitive on the international market.

## 2.5 The building blocks of the African Union

The African Union is an important organisation for many African countries because it embraces many of the sustainable development goals including energy and energy efficiency and because many of the EE measures work better, when implemented in a community of neighbouring countries, e.g. MEPS (Minimum Energy Performance Standards) and energy labelling.

The African Union consist of the following regional economic communities[20]:

- IGAD: Intergovernmental Authority on Development
- COMESA: Common Market for Eastern and Southern Africa
- EAC: East African Community
- SADC: Southern African Development Community
- ECOWAS: Economic Community of West African States
- AMU: Arab Maghreb Union
- CEN-SAD: Community of Sahel–Saharan States
- ECCAS: Economic Community of Central African States

The various regional economic communities are comprised as seen in Figure 8.

[20] Regional Economic Communities | United Nations Economic Commission for Africa (uneca.org)

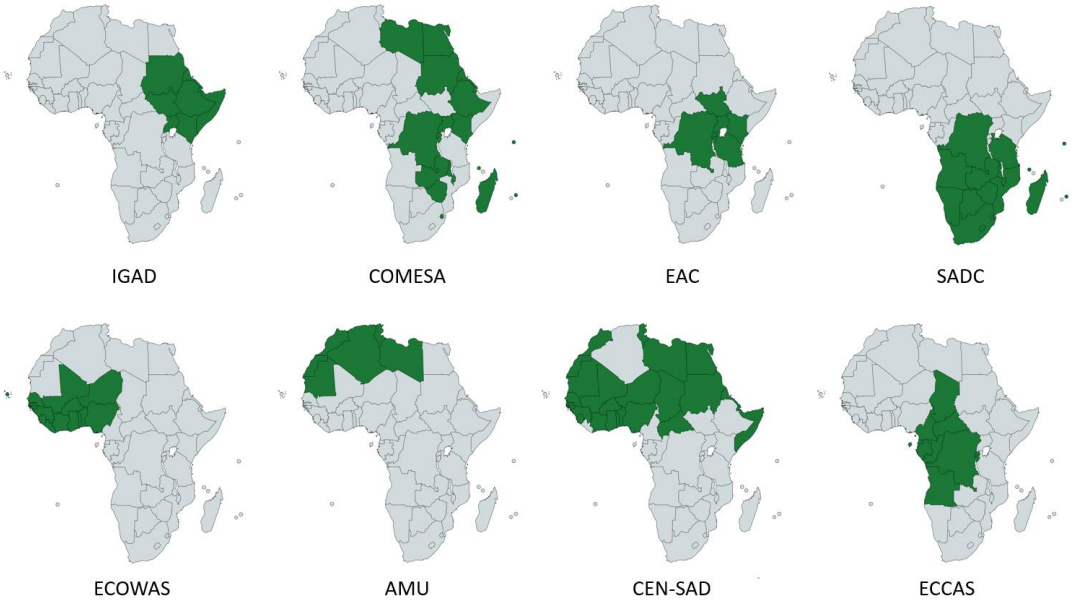



*Figure 8. Overview of the regional economic communities of Africa*

As can be seen from the figure above, Ethiopia is part of IGAD and COMESA and shares borders with countries in EAC and CEN-SAD. The communities act as platforms for developing regulations and sharing knowledge. It has been possible to identify some that are currently working on energy efficiency measures namely IGAD, COMESA, EAC, SADC and ECOWAS. These will be elaborated on in Section 4.

# 3 Ethiopian current energy efficiency policy and measures

## 3.1 Legislation

### 3.1.1 Regulation No 447/2019

A key legislation is the Regulation No. 447/2019 (hereafter referred to as "the Energy Regulation"). The Regulation is primarily targeted at actors responsible for the generation, transmission, distribution and sale of electricity. Conditions for obtaining and maintaining a license for these activities are described.

There is an in-built responsibility for transmission licensees (Article 24(2e)) and distribution and sales licensees (Article 25(4e)) to develop and maintain their systems to ensure efficiency, reliability and safety. Furthermore, distribution & sale licensees have the responsibility to implement any energy efficiency and conservation programs that are proven to be economically beneficial (Article 25(4l)).

The underlying principle of setting electricity tariffs that "*encourage efficiency, economical use of the resource and efficiency in performance*", amongst other motivations, are set out in Article 29(2) of the Energy Regulation. The need to increase tariffs (see Table 2) to make them at least cost reflective is effectively acknowledged in Article 29(3) of the same Energy Regulation.

Chapter 4 of the Energy Regulation, specifically in Articles 49 to 54, make provisions for energy management in industrial activities in Ethiopia. Industries may be designated by the PEA to be required to have at least one qualified person who is responsible for energy efficiency and conservation. Furthermore, designated industries will have to implement any energy conservation measures specified by the Authority, to carry out periodic energy audits, to report on energy use to the Authority, to keep records of energy consumption for at least 5 years and possibly to enter into a voluntary agreement with the Authority. Voluntary agreements could potentially require only the use of defined electrical equipment above a certain minimum energy efficiency.

Chapter 5 of the Energy Regulation is dedicated to matters of energy efficiency at the level of buildings. Provisions are made in Articles 55 and 56 for the development of codes, standards and/or labels with the aim of improving energy efficiency in buildings. The legal text of Article 56 suggests the consideration of the following areas:

- Reduction of excessive solar gain in buildings (overheating).
- Use of efficient air conditioning systems.
- Use of energy efficient construction materials (presumably this means materials that have good thermal performance and fittings that have good air-tightness).
- Optimisation of daylighting in buildings.
- Installation and use of machinery, equipment and materials that contribute to energy conservation.

This last point is especially broad and could be considered to include many typical household appliances as well as industrial equipment (if by the terms "buildings" and, later on, "designated buildings", factory buildings could also be applicable). Article 57 allows for limiting to application of Articles 55 and 56 on building codes to only certain types of "designated buildings". In Article 57(2), hot water generation and space heating systems are explicitly mentioned together with air conditioners. Any such designated buildings should have an energy audit carried out every three years. Given the lack of capacity for energy auditors, it is recommended that implementation should start with a very limited type of designated buildings (e.g. hotels above a certain total floor area, government office buildings above a certain floor area etc.).

Chapter 6 of the Energy Regulation provides details about the energy efficiency and conservation fund and how it should be managed by an Energy Board. The main purposes of the fund, stated in Article 58(1), are:

- To finance the implementation of short, medium and long term energy efficiency and conservation projects;
- To fund consultant, auditor, research & development activities related to energy efficiency and conservation;
- To finance demonstration projects and capacity building activities related to energy efficiency and conservation, and
- To finance public relations activities, information dissemination and promotional activities related to energy efficiency and conservation.

According to Article 62, the Board should be updated every 3 months about how the fund has been utilised.

#### 3.1.2 Proclamation No. 810/2013

Another highly relevant piece of legislation in Ethiopia is the so-called "Energy Proclamation". It defines many key terms relating the Ethiopian energy sector, for example:

- "Code": an organised set of procedures and practices prescribed by the directive of the Authority to be applicable with respect to electrical works or service level standards.
- "Energy audit": a systematic procedure: a) to obtain adequate knowledge of the existing energy consumption profile of a customer; b) to identify and quantify cost effective energy saving opportunities; and c) to report the findings.
- "Energy conservation": the ability to provide the same or higher level of products or services at lower energy consumption.
- "Energy efficiency label": a label affixed on an energy consuming asset to describe the asset´s energy performance in order to provide consumers with the data necessary to make an informed purchase.
- "Energy service company": a company that delivers energy efficiency improvement service with respect to a customer´s facility or premises and accepts payment for the service based, either wholly or in part, on the achievement of energy efficiency improvement.
- "Voluntary agreement": a contract between the Authority and any person on agreed targets with commitments and time schedules on the part of all participating parties to improve energy efficiency.
- "Fund": the Energy Efficiency and Conservation Fund established under Article 23 of the Proclamation.

The Energy Efficiency and Conservation Fund is of particular interest and Article 23 of the Energy Proclamation states that payments into the fund can come from diverse sources, namely: (i) government budget; (ii) loans and grants from international institutions; (iii) grants from NGOs; (iv) fines from non-compliant electrical equipment, appliances, buildings and industries not meeting energy efficiency requirements (fines up to Birr 100,000 mentioned in Article 30, together with jail terms up to 15 years), and (v) other sources.

Part two of the Proclamation established the Ethiopian Energy Authority (EEA), which is today the Petroleum and Energy Authority.

## 3.2 Energy efficiency measures

#### 3.2.1 Strategies and prioritisation

MoWE is responsible for the overall energy strategy and one of the priorities of the strategy is energy efficiency. Hereinunder, PEA and EEU are responsible for specific measures and activities for energy efficiency.

PEA is responsible for managing long-term and short-term EE programmes, set national targets, develop strategies and create guidelines. The EE strategy has been ratified and comprise among others 5 energy efficiency programs:

- Standards and labelling
- Energy audits in industrial sector and larger buildings and voluntary agreements for larger industrial facilities
- Public sector energy efficiency
- Building codes and labelling program
- Awareness training (energy auditing and ESCOs)

EEU is – in relation to energy efficiency – responsible for EE in the grid including distribution transformers, metering, security of electricity supply, access to electricity and tariffs. Regarding tariffs, see details in section 2.2.4.

### 3.2.2 Energy auditing

PEA is overall responsible for the energy auditing scheme and the authority has prioritised energy audits in the industry and big buildings, though the latter is at an early stage. Energy auditing is not mandatory, but for the last 8 years, PEA has been asking companies to make energy audits – in some cases the audits have been done for free just to increase awareness. Now, companies are approaching PEA to be audited, though it is not the role of PEA to do energy audits.

The energy auditing scheme was established as part of a 2-year EU Technical Assistance Facility programme. Energy audits of Ethiopian industry generally identified many low hanging fruit i.e. easy changes that require only little or no investment and do not require replacement of equipment.

There is no Ethiopian standard for conducting energy audits, but methods are influenced by different international standards and guidelines such as from ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers).

Audits have been carried out in in several larger Ethiopian industrial facilities e.g. breweries and leather tanning and producing cement, textile, steel and plastic.

Typical improvements of around 30% energy savings are in the areas of:

- Boiler operation.
- Steam distribution system.
- Condensate system and handling.
- Compressed air system leakage identification and sizing.
- Pumping systems.
- Motor loads and efficiency.
- Electrical power quality issues.
- Lighting systems.

PEA has developed a programme to train professionals in energy efficiency with the aim of awarding licenses to individuals and companies as energy auditor and Energy Service COmpanies (ESCOs). To date, the PEA has awarded licenses to 8 energy auditors and 7 ESCOs. To get an energy audit licence from PEA, the participant should attend 10 days of training; write a complete energy audit report for a factory and pass an exam.

Larger international companies that are increasingly setting up facilities in Ethiopia such as the brewery BGI Ethiopia often have a different attitude to energy efficiency because they have in-house teams dedicated to EE using their own energy auditors.

### 3.2.3 Voluntary agreements for larger industrial facilities

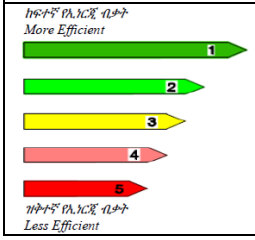
Voluntary agreement on energy efficiency has been established for 7 industrial enterprises. The enterprises are expected to implement ISO 50001 on energy management systems. This includes the development and annual reporting on an energy consumption reduction plan. As compensation, PEA should create incentives and financial support, however allocation of economic funds has still not been ratified. Therefore, there are less incentive for the enterprises to engage in the projects.

### 3.2.4 Minimum Energy Performance Standards and energy labelling

MEPS have so far only been set in Ethiopian standards for electric injera mitad stoves (two types) and for electric motors (in process of being ratified). These are products with a high share of energy consumption and relevant improvement potential. The MEPS is combined with energy labelling. MEPS for other products such as washing machines and refrigerators are considered or being planned.

MEPS and energy labelling is operated by PEA as a certification scheme. The manufacturer sends a product to PEA, who tests it and gives it a certificate. Additional laboratory facilities are required for appliance testing if they are to scale up the labelling scheme. The details are summarised in the table below.

*Table 3. Summary of Ethiopian energy efficiency legislation for products (stoves and motors)*

| | Clay Plate Resistor-Based Injera Mitad (CPRBIM) electric stoves | Open Resistor-Based Electric Stove (ORBES) | Induction-based electric motors |
|---|---|---|---|
| **Specifications** | 53 to 60 cm diameter cooking zone | 16 to 25 cm diameter cooking zone | |
| **Test method** | ES 4084:2017 | ES 6053:2018 | IEC 60034-2-1 |
|  | η > 80% efficiency | η > 60% efficiency | Proposed to phase in a MEPS Directive that requires all new motors to be IE2 standard (high efficiency) or better. Verification should be done prior to import. Reduced taxes are used as an incentive. |
| | 78< η ≤80% efficiency | 57< η ≤60% efficiency | |
| | 73< η ≤78% efficiency | 53< η ≤57% efficiency | |
| | 68< η ≤73% efficiency | 48< η ≤53% efficiency | |
| | 60< η ≤68% efficiency | 40< η ≤48% efficiency | |

Within the limits of this review, it has not been possible to assess in which degree the requirements and test methods (apart from the mentioned IEC test method) are aligned with international requirements and standards. Such alignments would benefit both imports and exports of appliances. For imports, the importers do not need to allocate extra efforts to demonstrate compliance with Ethiopian-specific energy efficiency requirements e.g. administrative costs of testing and producing suitable energy label and certificates and potentially adapting the products for being able to comply with requirements. For exports, the same occurs for the Ethiopian manufacturers to comply with the export markets.

There may however be local conditions in Ethiopia justifying different requirements or test methods, e.g. climate conditions and use patterns. Furthermore, there are products mainly used in Ethiopia like the injera mitad without international MEPS and test standards. In these cases, the recommendation would be to harmonise internationally as far as possible or use standards for products most similar to the Ethiopian products.

### 3.2.5 Public sector

One of the PEA's EE programmes is targeted the municipalities, where PEA promotes EE in street lighting. This is also driven by the desire to phase out mercury-containing lighting by moving to LED only. Around 50% of the street lighting is already retrofitted.

### 3.2.6 EE campaigns and activities

Campaigns and other activities have been carried out as part of international programmes or donor activities such as via:

- SouthSouthNorth: An international organisation implementing climate and development projects and support in multiple countries, with a specific programme for Ethiopia[21].
- Minimata Convention on Mercury and Clean Lighting Coalition[22]: The activity is focusing on phasing out of mercury-containing lighting in favour of LED-based lighting.
- CLASP: Collaborative Labelling and Appliance Standards program[23]:

An example is campaigns for replacing incandescent light with CFL and LEDs. A few years ago, a large campaign was carried out to replace sale of all incandescent bulbs with CFL and LEDs. Today it is only possible to get CFL and LED bulbs in Ethiopia, which is seen as a result of campaign activities and the general market transformation globally away from incandescent lighting.

More recently, a campaign has been carried out for replacing CFLs with LEDs via the Minimata Convention on Mercury and Clean Lighting Coalition activity. This led to a huge influx of LED products on the market to the point where there is no need for supply of CFLs. However, CFLs are considerably cheaper than LED and will continue to be in demand so long as they are on the market in Ethiopia.

### 3.2.7 Building codes

With budget from GIZ, the PEA is working on developing building codes and promoting EE in buildings, however, it is at an early stage. The first steps are to study and map the energy consumption of the building sector. Voluntary sustainability certification for buildings is considered.

### 3.2.8 Electricity distribution system

Customer connections are projected to increase to 75% by 2030 facilitated through the 'Light for all Project'. Today around 35% of households are connected to the national grid.

The reliability of electricity supply is a large issue due to outdated parts of the distribution grid, which often fails due to intense rain. Furthermore, the transmission and distribution losses are quite high, about 25-30%. Part of this is however non-technical losses, i.e. theft.

A World Bank activity is targeted improvement of the reliability in regional cities and in the capital.

There is an interest at EEU to take EE into account when expanding the grid or replacing older parts for such as switchgear and transformers in the distribution network. Currently, a pilot project is being carried out where 1,000 distribution transformers will be fitted with smart meters to monitor infrastructure performance and measure the energy efficiency of the transformers.

Smart meters are also beginning to be installed by the EEU – especially for large industrial customers (5,000 such customers have a smart meter) to substitute the current manual meter readings. One of the EEU's aims of the smart meters is to reduce the losses including theft.

[21] https://southsouthnorth.org/portfolio_page/ssn-in-ethiopia/
[22] https://cleanlightingcoalition.org/
[23] https://www.clasp.ngo/programs/regions/africa/

# 4 Energy efficiency policies relevant for Ethiopia

In this section, we describe international supporting and collaborating activities in Africa that are or may be relevant for the Ethiopian government and furthermore international EE policies and measures that can be of inspiration for Ethiopia.

## 4.1 International organisations and collaborations in Africa

There are a number of international organisations working in Africa that are related to the energy markets; a number of which are described below. The types of projects that these organisations are involved in gives some idea of the broader African context and associated priorities in the energy sector. See an overview and brief description in Table 4.

*Table 4. International organisations working in Africa whose activities relate to EE.*

| International organisations focused exclusively on Africa | |
|---|---|
| **Name** | **Relevance of activities to energy efficiency** |
| RAERESA (Regional Association of Energy Regulators for Eastern and Southern Africa) | RAERESA works on harmonizing legal and regulatory frameworks, promotes energy efficient technologies and practices and develop regional capacities. Ethiopia is strongly involved with the work of the association. |
| COMESA (Common Market for Eastern and Southern Africa) | COMESA has as their main focus to form a large economic and trade unit that can remove some of the barriers that are faced by the individual member states. Ethiopia is a member. COMESA initiated the 'Regional Harmonization of Regulatory Frameworks and Tools for Improved Electricity Regulation in COMESA' project in 2021[24]. |
| IGAD (Inter-Governmental Authority on Development) | IGAD in Eastern Africa has as their goal of 'transformation towards sustainable development, resilience and stability in the IGAD Region'. In 2022 they made a Regional Climate Change Strategy and Action Plan for 2023-2030. Ethiopia is a member. |
| AFREC (AFRican Energy Commission) | AFREC is the energy agency of the African Union (AU), under the Commission for Infrastructure and Energy, in charge of coordinating, harmonising, protecting, conserving, developing, rational exploitation, commercialising and integrating energy resources on the African continent. |
| EACREEE (East African Centre of Excellence for Renewable Energy and Efficiency) | EACREEE works to strengthen regional cooperation in the area of renewable energy and energy efficiency. The centre was founded by the East African Community (EAC) |
| EAC (East African Community) | EAC is an intergovernmental organisation working to ensure a prosperous, competitive, secure, stable and politically united East Africa. They are collaborating with the Southern African Development Community (SADC) on promoting energy efficient as part of The Energy Efficient Lighting and Appliances (EELA) project |
| SADC (Southern African Development Community) | SADC is an organisation similar to EAC and also have a Centre for Renewable Energy and Energy Efficiency (SACREEE). They have made the 'Southern Africa Renewable Energy and Energy Efficiency Strategy and Action Plan' in 2019. |
| SE4ALL (Sustainable Energy for All) | SE4ALL has as one of their three objectives to 'double the global rate of improvement in energy efficiency'. The SE4ALL Africa Hub is composed of 44 African countries, including Ethiopia. |
| AEEP (Africa-EU Energy Partnership) | The overall aim of the AEEP is to facilitate the achievement of universal access to affordable, sustainable and modern energy services in Africa. They do not focus specifically on energy efficiency. |

[24] Multinational - Regional Harmonization of Regulatory Frameworks and Tools for Improved Electricity Regulation in COMESA - Project Appraisal Report | African Development Bank Group - Making a Difference (afdb.org)

| | |
|---|---|
| AEPEA (Association of Energy Professionals Eastern Africa) | AEPEA works to promote energy efficiency and conservation and was founded as a part of the Association of Energy Engineers (AEE). |
| ACES (Africa Centre of Excellence for Sustainable Cooling and Cold-Chain) | ACES is an organization that delivers technical assistance and knowledge on the entire cold-chain. The organisation also demonstrates cooling solutions to create sustainable and smart cold-chains e.g., by creating Community Cooling Hubs (CCH). |
| **International organisations not focused exclusively on Africa** | |
| **Name** | **Relevance of activities to energy efficiency** |
| The Clean Cooling Collaborative | Clean Cooling Collaborative (formerly K-CEP) is an initiative of ClimateWorks Foundation focused on transforming the cooling sector and making efficient, climate-friendly cooling accessible for all. |
| CLASP (Collaborative Labelling and Appliance Standards Program) | CLASP is an organisation working with the promotion of appliance & equipment energy performance and quality. In April, CLASP and the South African National Energy Development Institute (SANEDI) formalized a partnership to promote energy efficient household appliances and commercial equipment through a broad scope of activities[25]. |
| UNEP (United Nations Environment Programme) | UNEP is the leading global authority on the environment. They engage in various projects related to EE in Africa and have made the report 'Accelerating Energy Efficiency: Initiatives and Opportunities – Africa'[26] in 2015. |
| AEE (Association of Energy Engineers) | The AEE is an international NGO, who works to promote sustainable development in the energy industry. They offer accreditation services for Certified Energy Manager (CEM) and Certified Measurement and Verification Professional (CMVP) through their South African Chapter. |
| U4E | U4E works to help countries implement an integrated policy approach to enable a sustainable and cost-effective transformation to energy-efficient lighting, equipment and appliances. They have been part of creating the African Energy Efficiency Program. |
| BASE (Basel Agency for Sustainable Energy) | BASE is a Swiss foundation working to unlock investment in climate change solutions and transform markets. |

## 4.2 Relevant funds

Access to finance is crucial to the success of any programmes to improve energy efficiency and some examples of relevant funds are:

- The Green Climate Fund: The world's largest climate fond with the purpose of supporting developing countries in taking climate action. Has initiated Readiness projects in 8 African countries, with the goal of transforming the markets to energy efficient refrigerators and distribution transformers.
- SEFA: The Sustainable Energy Fund for Africa (SEFA) is managed by the African Development Bank and invests in renewable energy and energy efficiency in Africa.
- AfDB: The African Development Bank Group supports sustainable economic development and social progress in its regional member countries.

## 4.3 Relevant guidelines

Guidelines can be of particular help when trying to implement EE programmes and legislation since they allow experience and lessons learned from previous projects to be communicated to less experienced stakeholders. Two particularly relevant sets of guidelines are:

[25] Advancing Appliance Efficiency in South Africa - CLASP
[26] Accelerating Energy Efficiency: Initiatives and Opportunities - Africa - Copenhagen Centre on Energy Efficiency (unepccc.org)

- Sustainable Public Procurement guidelines: A tool to design and implement Sustainable Public Procurement (SPP) policies and action plans. The guidelines were created by the 'Marrakech Task Force' and are piloted by the UNEP.
- Model Regulation Guidelines: The U4E has created the 'Model regulation guidelines for lighting, appliances and equipment' which contain material on lighting, refrigerators, air conditioners, distributions transformers and electric motors. The guidelines are aimed at governments to be used for achieving sustainable market transformation.

## 4.4 Examples of policies and schemes related to EE

### 4.4.1 African Energy Efficiency Programme

Lighting, industrial motors, residential refrigeration, distribution transformers and room air conditioners are identified as the main areas for energy efficiency improvements in Africa. Lighting is found to have the largest potential on the short term, whereas room air conditioners and residential refrigeration is deemed to have the largest potential moving towards 2040.

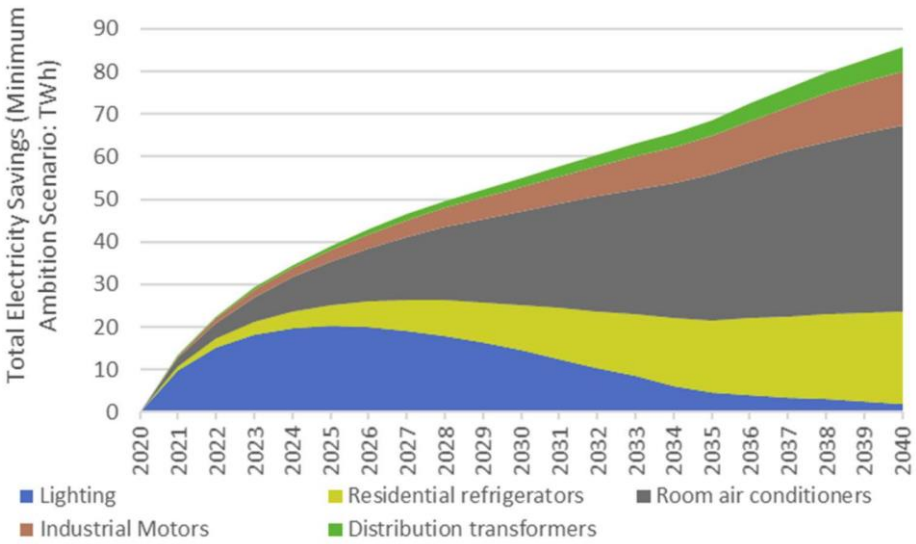



*Figure 9. Annual energy savings potential of various products. Taken from 'African Energy Efficiency Programme'*

The programme creates a roadmap with the goal of facilitating a market transition toward eco-efficient lighting, appliances, and equipment, and outlines 5 steps:

1. Development of the regional market assessments and quantitative benefits.
2. To support harmonization efforts in the African sub-regions for MEPS and energy labelling regulatory frameworks.
3. To establish monitoring, verification and enforcement (MVE) protocols and activities in the African market.
4. To support the development of harmonized tools for Public Procurement of higher performance electrical products and energy-related equipment in Africa.
5. To facilitate national support and the communication of national and regional market transformation efforts.

The African Energy Efficiency Programme divides Africa into 5 subregions, based on the following 3 criteria:

1. Commercial activities for the selected products at the sub-region level or members of the same commercial block.

2. Similar levels of Energy Performance Standards/Labels and/or resemblance of the industrialization level.
3. Geographical proximity.

Here Ethiopia is grouped together with Sudan, South Sudan, Uganda, Kenya, Somalia, Rwanda, Burundi, Djibouti and Eritrea.

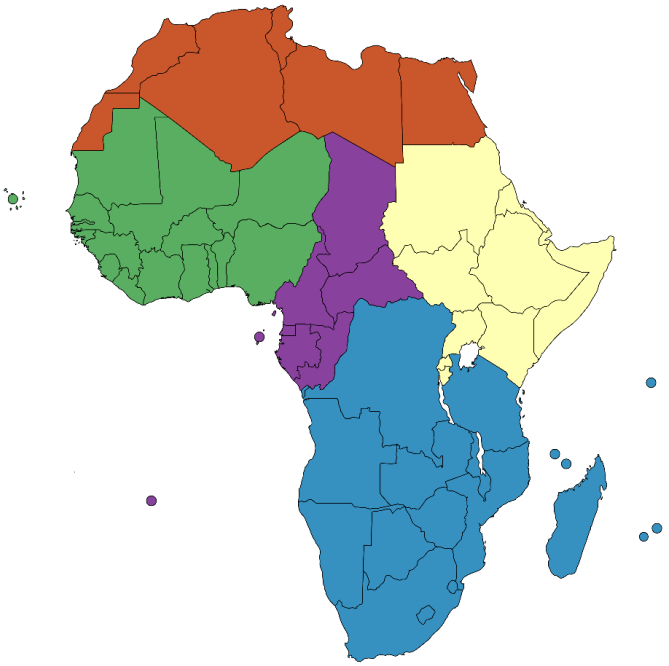


*Figure 10. The five subregional divisions made in the 'African Energy Efficiency Programme'.*

The African Energy Efficiency Programme argues for energy efficiency initiatives to be adopted at a regional level rather than creating unique solutions in each individual country, and list the following 6 benefits of doing so:

1. More effective and sustainable market transformation[27].
2. Avoidance of isolated or stand-alone efforts or their duplication.
3. Efficient use of limited resources.
4. Engagement of a wider set of national and regional stakeholders to secure political willingness and commitment.
5. Knowledge/information exchange to share capacities, tools, methods and infrastructure.
6. Reduction of commercial barriers.

### 4.4.2 EELA Regional EAC-SADC project

The East African Community (EAC) and the Southern African Development Community (SADC) has made a regional project to promote energy efficient lighting and appliances called EELA[28]. Ethiopia is not part of this project. A map of the two organizations member states can be seen in Figure 11.

[27] Market transformation is the concept of inducing a change in the market towards higher efficiency and sustainability. This is done through collaboration between multiple stakeholders such as businesses, consumers, industry associations and policymakers.
[28] EELA approach to change | EELA PROJECT (eela-project.org)

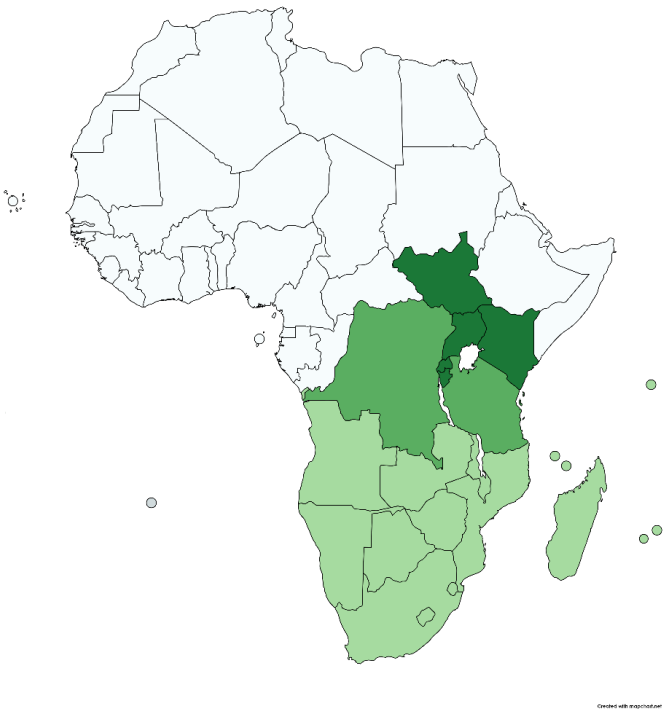


*Figure 11. Overview of the countries that are part of the EELA project. The East African Community (EAC) highlighted in dark green, countries that are part of both SADC and EAC highlighted in a lighter green, and The Southern African Development Community (SADC) highlighted in light green.*

The project started in 2019 and is running until 2024. The project aims to implement a broad range of activities relating to energy efficient lighting and appliances, such as:

- Harmonized MEPS for various product groups.
- Standards.
- Accreditation bodies and testing facilities.

Part of the project output has been the report: 'Overview of the Market on Refrigerating Appliances and Room Air Conditioners in East and Southern Africa'[29]. Figure 12 below shows the projected savings in the participating countries. There are large population differences between the countries, but even among the larger countries (Tanzania, Kenya and Uganda), which are of similar population size, there were found to be large differences between the potential energy savings from improved air conditioners and refrigerators.

For refrigerators, the largest savings are estimated for Kenya, whereas the potential savings for Tanzania and Uganda is relatively modest. For air conditioners, the projected savings are the largest for Kenya and Tanzania, whereas the are again modest for Uganda. The reason for these differences are not clearly described in the report, but might have to do with the lower electrification rate of Uganda and Tanzania (similar to Ethiopia) compared to Kenya, differences in the current level of import of these appliances, and the differences in climates, where Kenya is primarily hot desert and steppe climate, and Uganda and Tanzania have more tropical climates. Based on the electrification rate and climates it is expected that

[29] SADC_EAC_Market-Assessment_Cooling_20210205_Final.pdf (united4efficiency.org)

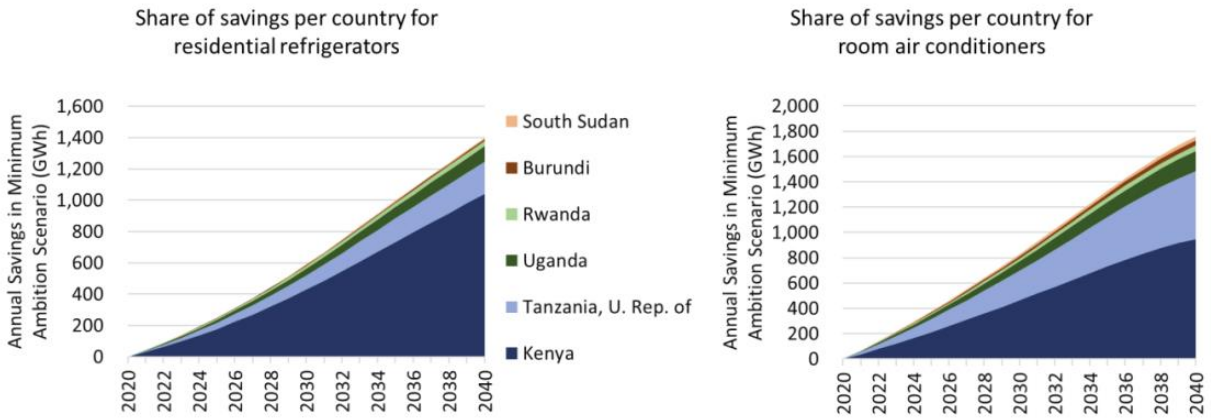



*Figure 12. Projected energy saving potentials for refrigerators and air conditioners in 6 African countries. Source: "SADC-EAC: Overview of the Market on Refrigerating Appliances and Room Air Conditioners in East and Southern Africa"*

similar projections for Ethiopia would follow a trajectory more similar to Uganda and Tanzania than to Kenya.

### 4.4.3 IGAD Regional Climate Change Strategy and Action Plan (2023-2030)

The Intergovernmental Authority on Development (IGAD) have created a strategy and action plan for 2023-2030, which highlights 6 points related to energy efficiency[30], namely:

1. Promoting standards for energy efficiency in the region.
2. Promoting the use of energy efficient technologies and sources in urban development.
3. Raise energy efficiency in power production, transmission and distribution through appropriate investments.
4. Raise energy efficiency in agricultural and industrial processes through appropriate policies and investments.
5. Raise energy efficiency in domestic and commercial/ service sectors through appropriate policies and investments.
6. Raise energy efficiency in transport sector through appropriate policies and investments.

The countries in IGAS are presented in Figure 13Figure 14.

[30] IGAD Regional Climate Change Strategy and Action Plan (2023-2030) - ICPAC

*Figure 13. The Intergovernmental Authority on Development (IGAD) highlighted in green*

### 4.4.4 The GCF Readiness projects

The Green Climate Fund Readiness projects are being implemented in Malawi, Namibia, Zambia and Zimbabwe, Botswana, Eswatini, Lesotho and Tanzania with the aim of creating mandatory MEPS and labelling schemes[31]. The work is done through the United Nations Environment Programme (UNEP) and is coordinated with efforts by UNEP's United for Efficiency (U4E) initiative to harmonize standards.

The Readiness project is named "Developing a national framework for leapfrogging to energy efficient appliances and equipment (refrigerators and distribution transformers) through regulatory and financing mechanisms". The countries in the projects are presented in Figure 14.

[31] GCF Readiness Projects in Southern Africa: National Frameworks for Energy-Efficient Appliances through Regulatory and Financing Mechanisms | SACREEE

*Figure 14. Countries doing Readiness projects under BASE and GCF*

**Example: MEPS on distribution transformers and refrigerators in Botswana**

Botswana are one of the countries in the midst of implementing the 'National Framework for Leapfrogging to Energy Efficient Appliances and Equipment'. As part of this initiative, refrigerators and distribution transformers have been identified as key areas for energy efficiency improvements.

*Distribution transformers in Botswana*

Research has indicated that 30% of distribution losses are due to inefficient transformers[32]. To improve in this area, MEPS are being developed for distribution transformers in Botswana. The MEPS were projected to be published in June 2023, but at the time of writing (June 2023) are still not publicly available.

As a part of this work, potential financing options were also identified[33]:

- Utility Regulatory Frameworks;
- Guarantees;
- Public Private Partnerships;
- Energy Savings Performance Contracting through ESCOs;
- Revolving Loan Funds, and
- Bulk Procurement.

*Refrigerators*

The initiative also includes a 'National Policy Roadmap Plan' for the update of efficient refrigerators[34]. The roadmap contains both the development of MEPS as well as a national labelling scheme.

To ensure uptake of the energy efficient refrigerators potential costumer financing mechanism has been identified:

[32] Minimizing Energy Losses: Botswana Increases Efficiency for Distribution Transformers - CLASP

[33] Financing Mechanisms for Refrigerators and Distribution Transformers in Botswana | Climate Technology Centre & Network | Mon, 03/13/2023 (ctc-n.org)

[34] National Policy Roadmap plan: Plan for Uptake of efficient Refrigerators in Botswana | Climate Technology Centre & Network | Mon, 03/13/2023 (ctc-n.org)

- Dealer Financing;
- Microfinance/Credit Line;
- Savings Groups;
- On-Bill Financing, and
- Financial Incentives (Rebates, Tax Credits and/or Subsidies).

### 4.4.5 Projects in the EA-SA-IO Region

**Renewable Energy and Energy Efficiency Strategy & Action Plan (REEESAP) – 2020**

The Renewable Energy and Energy Efficiency Strategy & Action Plan for Eastern Africa, Southern Africa and the Indian Ocean Region (REEESAP EA-SA-IO) lists the following categories related to EE[35]:

- Standards of equipment/appliances, labelling and testing facilities.
- Measurement and Verification of achieved energy savings.
- Accreditation, adoption and deployment of energy management systems.
- Various energy efficiency and Demand Side Management measures for the electricity end use sector (CFLs and LEDs for lighting, Time of Use tariffs, prepayment and smart meters, hot water load control, power factor corrections, power alert, building designs). These were considered in context of demand side management (DSM) in various applications of the residential, commercial and industrial sectors.
- On the supply side, transmission and distribution losses for the power sector such as power factor corrections, power quality monitoring and smart grids and related advanced metering infrastructure.
- Technology and fuel substitutions in cooking/heating and cooling for household, public and social sectors, industry (small and large scale), for example: ICS; alternative fuels-LPG, biogas, biofuels; charcoal production-kiln designs, efficient air conditioners and motors).

It was noted in 2020, in a combined meeting of the Portfolio Committees on Renewable Energy and Portfolio Committees on Environment and Energy Efficiency of the Regional Association of Energy Regulators for Eastern and Southern Africa (RAERESA), that the REEESAP EA-SA-IO was *"the key overarching regional instrument that would provide guidance to the development of RE/EE strategies and action plans for MS and mobilization of additional finance for implementation of RE/EE projects".* Ethiopia chaired the meeting and was at the time Chair of the Portfolio Committee on Renewable Energy.

**Project on Enhancement of a Sustainable Regional energy Market (ESREM) – 2017**

The countries involved in this project were all the Regional Economic Communities (RECs) in the EA-SA-IO Region[36]. The project spanned 48 months and started in end of May 2017. The main deliverables of the project were:

- Regional Harmonization of Energy Regulatory Framework.
- Renewable Energy and Energy Efficiency.
- Capacity Building.

Outcomes of the project included the creation of 31 reports on 'Regional Harmonization of Energy Regulatory Framework', 12 reports and guidelines on 'Renewable Energy and Energy Efficiency' and international training of 363 officials.

[35] REEESAP_EA-SA-IO_Summary-Report.pdf (comesa.int)
[36] Our Projects – RAERESA (comesa.int)

*Figure 15. The Eastern Africa, Southern Africa and the Indian Ocean Region outlined in green.*

### 4.4.6 ECOWAS Refrigerator and Air Conditioners Initiative (ECOFRIDGES)

The countries in the Economic Community of West African States (ECOWAS), have initiated the ECOFRIDGES initiative with pilot projects in Ghana and Senegal[37]. The main aim of the initiative is to unlock financing for energy efficiency and climate friendly cooling products. However, the initiative also includes actions on proper disposal of used appliances, product testing, monitoring and verification, policy considerations, and awareness campaigns.

The findings are to be made into a toolkit which, together with training, will be shared with the other countries in ECOWAS.

The main components of the initiative consist of:

- Conducting national market assessments on the equipment, key stakeholders and practices.
- Develop Financial Mechanisms to promote efficient, climate-friendly refrigerators and air conditioners, with eligibility criteria adapted from U4E's Model Regulation Guidelines.
- Monitor the initial operation of the scheme and enforce eligibility criteria and program protocols.
- Collect and recycle/process old, operable products.
- Conduct communication campaigns to raise awareness and interest.
- Provide local level capacity-building and more generally for others in ECOWAS based on lessons learned.

[37] ECOWAS Refrigerators and Air Conditioners Initiative (ECOFRIDGES) - United for Efficiency (united4efficiency.org)

*Figure 16. Countries part of the ECOFRIDGES initiative – countries in ECOWAS*

### 4.4.7 South Africa's Appliance Energy Efficiency Standards and Labeling Program

South Africa have already created MEPS and labelling schemes for various appliances[38]. However, no MEPS or labelling schemes are made for Injera Mitads (likely because these are not typically used in South Africa), cook stoves and televisions. The appliances where MEPS or labelling schemes are in place in South Africa can be seen in the table below.

*Table 5. Electrical products and appliances with energy efficiency requirements in South Africa*

| Appliance | MEPS | Labelling scheme |
|---|---|---|
| Air conditioners | X | X |
| Audio-visual equipment | X | X |
| Dishwashers | X | X |
| Electronic ovens | X | X |
| Freezers | X | X |
| Fridge-freezers | X | X |
| Storage water heaters | X | X |
| Tumble dryers | X | X |
| Washer-dryers | X | X |
| Washing machines | X | X |
| Light bulbs | | X |

[38] Regulations and Standards (savingenergy.org.za)

## 4.5 European Union EE policy and measures

For reference and potential inspiration, a brief summary of main European policies relating to Member States' activities and targets for EE; to EU MEPS and energy labelling of energy related products and EE in industry and in buildings is provided here.

The overarching EU policy is the European Green Deal aiming at transformng the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050; economic growth decoupled from resource use; and no person and no place left behind.[39]

### 4.5.1 The Energy Efficiency Directive

The Energy Efficiency Directive (EED, 2012/27/EU)[40] sets targets for total energy consumption of the European Union and a framework within which targets can be set at Member State level.

Some of the most relevant points covered by the EED are:

- Role of public bodies in setting the example by demanding EE in new or renovated buildings owned by them, and in procurement criteria for diverse energy-related products and services.
- Promoting the availability of high quality and cost-effective energy audits and auditors for the industry and other enterprises and for buildings.
- Installation and improvement of metering of gas, electricity and heat and ensuring that they are remotely readable.
- Improving EE in power and heat generation, transformation, transmission and distribution.
- Requirements regarding energy services.

There are also other policies that are more specifically focused on certain relevant areas, namely buildings, energy-using appliances and heavy industry.

### 4.5.2 EU policies promoting EE in energy-related products

One main piece of EU legislation here is the Directive (EU) 2017/1369, which sets out a framework for the labelling of energy-related products from A to G based on their energy efficiency. More specific rules for different product groups are later defined in specific pieces of legislation for each product group.

Directive (EU) 2017/1369 also establishes an online database of energy-related products (known as EPREL[41], European Product Registry for Energy Labelling). Entries can be searched by different product categories and filtered for different technical criteria and by energy class. The main product categories currently available are:

- Air conditioners and comfort fans;
- Cooking appliances (for example see energy labelling and ecodesign regulations);
- Dishwashers;
- Space and water heaters;
- Lighting (for example see energy labelling and ecodesign regulations);
- Local space heaters;
- Fridges and freezers (for example see energy labelling and ecodesign regulations);
- Solid fuel boilers;
- Electronic displays including televisions;
- Tumble dryers;
- Ventilation units;
- Washing machines and washer-dryers, and

[39] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[40] Directive 2012/27/EU, available online here.
[41] See more details online here: https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/product-database_en#consult-the-database

- Tyres.

While the Energy Labelling is mandatory, there is no strict requirement on what the energy class must be for a given product. Therefore, in order to oblige manufacturers to push towards higher EE, there is another framework directive, namely Directive 2009/125/EC on ecodesign, that allows a minimum energy efficiency to be established for different energy-related products. Products that fail to meet relevant minimum requirements cannot be placed on the EU market. Many products are both covered by energy labelling and ecodesign requirements, while others, such as electric motors, are only covered by ecodesign.

The ecodesign directive also establishes mechanisms for market surveillance to check that products on the market actually comply with the minimum EE requirements and match the claims on the energy label. Experience to date in Europe has shown that resources available for market surveillance are generally insufficient and that some product groups are particularly vulnerable to cheaper but non-compliant products entering the EU market, especially via e-commerce.

### 4.5.3 EU policies promoting EE in industry

There are two main policies that create a combination of voluntary and mandatory pressures that directly and indirectly encourage a shift to more energy efficient production in the larger industrial production processes. As mentioned under the Energy Efficiency Directive, there is an energy auditing requirement for the industry over a certain size. Furthermore, there are also MEPS (ecodesign requirements) for industrial products such as electric motors and pumps.

The Industrial Emissions Directive (IED) 2010/75/EU sets mandatory legislation to define best available techniques (BAT) in given industrial sectors and activities. The legislation focuses primarily on emissions to air and to water from activities with a high pollution potential. However, the BAT concept also includes EE (see Article 11(f) and Annex III to the Directive). However, it is worth noting that EE is not promoted at all costs, and an integrated approach between emissions of pollutants, EE, waste management and accident prevention should always be maintained (see recital 3 of the Directive). Furthermore, in cases where EE of fuel combustion processes is involved that led to emissions of CO2, Member States are allowed to not impose mandatory limits on EE since the drive to EE is already being motivated by the EU Emissions Trading Scheme (ETS).

The ETS (Directive 2003/87/EC) is a cap and trade mechanism that has been gradually phased in over the last 15-20 years for defined activities that result in large and centralised emissions of CO2. Operators of these activities are given free allowances up to a sector specific benchmark (typical a value that is around the average of the top 10% in terms of CO2 emissions). Any CO2 emissions above this benchmark have to be purchased in auctions. Such a mechanism already encourages industry to improve the energy efficiency of equipment that results in CO2 emissions via fuel combustion. Money that is raised from the sale of CO2 allowances in auctions are used in “Global Energy Efficiency” and “Renewable Energy” funds. This includes the modernisation of existing energy infrastructure, in improving energy efficiency of middle and low-income households (via efficient heating systems and insulation) and to finance research into the development of new energy efficient technologies.

The sectors are covered by the IED and/or the ETS are shown in Table 6.

*Table 6. Selected industrial sectors and activities covered by the IED and ETS in the EU*

| Sector | Sub-sector | IED | ETS |
|---|---|---|---|
| Energy industries | Fuel combustion | If ≥ 50 MW | If ≥ 20 MW |
| | Refining of mineral oil and gas | No default threshold | No default threshold |
| | Production of coke | No default threshold | No default threshold |
| | Gasification or liquefaction of coal or other fuels | If ≥ 20 MW | Not covered by ETS |

| Sector | Sub-sector | IED | ETS |
|---|---|---|---|
| Production and processing of metals | Metal ore roasting or sintering (including sulphide ore) | No default threshold | No default threshold |
| | Production of pig iron or steel (primary or secondary fusion) | If production capacity > 2.5 t/hr | If production capacity > 2.5 t/hr |
| | Ferrous metal hot-rolling mills | If >20t crude steel/hr capacity | If total rated thermal input >20 MW |
| | Ferrous metal smitheries | If >50 kJ/hammer and calorific power >20 MW | |
| | Application of fused metal coats to ferrous metals | If input >2t crude steel/hr | |
| | Operation of ferrous metal foundries | If production capacity >20 t/day | |
| | Production of non-ferrous crude metals | No default threshold | |
| | Melting, including alloyage, of non-ferrous metals | If melting capacity >4 t/day (for Pb or Cd) or >20 t/day for other metals | |
| | Surface treatment of metals or plastics using an electrolytic or chemical process | When treatment vats >30m$^3$. | Not covered by ETS |
| Mineral industry | Cement clinker production | If rotary kilns >500 t/day or other kilns >50 t/day in other kilns | If rotary kilns >500 t/day or other kilns >50 t/day in other kilns |
| | Lime production | If kilns >50 t/day | If kilns >50 t/day |
| | Magnesium oxide production | If kilns >50 t/day | If kilns >50 t/day |
| | Drying of calcination of gypsum | Not covered by ETS | If total rated thermal input > 20 MW |
| | Production of asbestos or manufacture of asbestos-based products | No default threshold | Not covered by ETS |
| | Manufacture of glass, including glass fibre | If melting capacity > 20 t/day | If melting capacity > 20 t/day |
| | Melting mineral substances, including mineral fibre productions | If melting capacity > 20 t/day | If melting capacity > 20 t/day |
| | Manufacture of ceramic products | If production capacity > 75 t/day and/or kiln capacity >4m$^3$ and setting density >300kg/m$^3$ | If production capacity > 75 t/day |
| Chemical industry | Production of hydrocarbons, plastics, synthetic rubbers, dyes, pigments, surfactants etc. | No default horizontal threshold | No default horizontal threshold |
| | Production of inorganic chemicals such as ammonia, chlorine, nitric acid, phosphoric acid, sulphuric acid, sodium hydroxide etc. | No default horizontal threshold | No default horizontal threshold |
| Other activities | Production of pulp from timber or other fibrous materials | No default threshold | No default threshold |
| | Production of paper or card board | If production capacity >20 t/day | If production capacity >kjiuo9999999920 t/day |
| | Production of wood-based panels | If production capacity >600 m$^3$/day | Not covered by ETS |
| | Pre-treatment of textile fibres | If treatment capacity >10 t/day | Not covered by ETS |
| | Tanning of hides and skins | If treatment capacity >12 t/day | Not covered by ETS |

Some examples for industries that could be relevant in Ethiopia are provided below.

- Cement clinker production: In the BAT legal text[42] requires general techniques to ensure EE, such as computer-based automated controls, modern gravimetric solid fuel feed systems, the use of high efficiency grinding equipment and to use dry process kilns with multistage preheating and precalcination. The specific energy consumption of these kilns should be no higher than 3,300 MJ/t clinker.
- Textile production: In the BAT legal text[43], operators are required to have an Environmental Management System (EMS), which includes an EE plan and annual energy audits. Specific measures to improve EE in compressed air systems, for spinning, weaving, treatment of cotton and other areas are also described.

[42] Commission Implementing Decision 2012/163/EU, available online here.
[43] Commission Implementing Decision (EU) 2022/2508, available online here.

If the Ethiopian government wanted to promote energy efficiency via legislation in particular sectors, then the IED would be an important source of inspiration. Each set of BAT Conclusions is backed up by an extensive (often 600 to 1,000 pages long) BAT Reference document (generally referred to as BREF documents). These reference documents offer all the information necessary for governments wanting to base similar requirements in their non-EU country for any new industrial factories being built by international companies.

### 4.5.4 EU policies promoting EE in buildings

The Energy Performance of Buildings Directive (EPBD, 2010/31/EU) lays down a common general framework for a methodology to calculate the EE of buildings. It introduces the concept of nearly zero energy buildings and the main aspects of a building design that dominate its energy efficiency, which are:

- Thermal characteristics (capacity; insulation; passive heating; cooling elements and thermal bridges);
- Heating insulation and hot water supply (especially cogeneration and district heating/cooling);
- Air-conditioning installations;
- Natural and mechanical ventilation systems;
- Built-in lighting installation (and natural lighting);
- The design, positioning and orientation of the building;
- Passive solar systems and solar protection;
- Indoor climatic conditions;
- Internal loads.

The Directive also promotes “Smart Readiness” of buildings so that energy systems can be controlled automatically and reduce the potential for poor control of building technical systems by building managers by letting Building Automated Control Systems (BACS) adjust building technical systems to work within predefined parameters.

The EPBD also sets the basis for Energy Performance Certificates (EPCs) for buildings and that these EPCs must be shown when putting the building up for rent or sale. The EPCs basically provide an A to G style energy label for the whole building and are based on design calculations, as well as a variety of other information that may differ between Member States. However, experience has shown that many of these EPCs can be misleading in terms of actual energy consumption of buildings – with the main reasons beings that the design calculations being: (i) calculations are not able to adequately capture the wide range of occupant behaviours that can happen in real life, and (ii) that sometimes the building is not constructed as it was originally designed.

## 4.6 Other countries

Beyond the EU, inspiration can perhaps be gained from approaches in place for energy efficient appliances in the two largest producers of such products (i.e. the USA and China), or from the African country that is arguably most advanced in this area (South Africa).

In the USA, especially the voluntary Energy Star programme managed by the US EPA is globally recognised and also applied outside USA[44]. It covers a broad range of products and buildings. MEPS are also used in USA through the DoE (Department of Energy) rulemakings.[45]

[44] www.energystar.gov
[45] https://www.energy.gov/eere/buildings/rulemakings-and-notices

# 5 Analysis of impact, barriers and drivers

Based on the results of the information collection, including the interviews, and assessments provided in the previous sections, we have selected the following sectors and areas for further analysis as they have the largest energy efficiency potential:

- Industry
- Households
- Buildings
- Electricity distribution
- Awareness and training

For all the areas mentioned, a substantial increase of the tariffs would naturally be a very important driver, however, this is already a set target and technical assistance is provided by the World Bank to reach the target. See Section 2.2.4. Therefore, it is not seen as a driver that a strategy for energy efficiency should set as a pre-condition, rather see it as a desired development that over time will support substantially the level of energy efficiency carried out.

## 5.1 Industry

For the industry, three main measures have been selected for analysis:

- Energy audits and energy management
- Industrial cooling
- MEPS for electric motors

### 5.1.1 Energy audits and energy management

*Impacts*

Energy auditing is crucial for industries to understand and optimise their energy consumption. There are currently two mindsets in the industrial sector regarding energy auditing (i) an in-house approach taken by international companies that apply their own standards, and (ii) a very limited approach applied by Ethiopian companies using external auditors.

Based on our interviews with the PEA and an energy auditor, it is estimated that an energy audit typically identifies saving potentials of around 30%. The energy auditor's experience was that 80-90% of these savings required no or low investments to achieve. Hereinunder is also the establishment of good energy management practices. Thus, there is a significant potential for cost efficient energy savings by expanding the use of energy audits.

A longer-term potential for energy savings could be released via the finalisation of the ratification of the MEPS for electric motors. Electric motors are a large single type of energy consumer in the industry, and they often have a lifetime of 15-20 years. Therefore, setting EE requirements for the sale of new electric motors will be an important long-term element of an EE industry strategy.

*Barriers*

The main barrier for carrying out energy audits and barrier for implementing the recommended measures if the audit has been carried out is the artificially low electricity prices, which means that often the economic benefits are quite small. Another barrier is lack of awareness in the top management of the companies.

Currently, the company's primary motivation for having energy audits conducted is if costumers (other companies) are asking for data on their energy consumption. It may also be other third-party requests such as the government providing the demand for audits or a donor activity and/or supporting local companies.

This does not result in many energy audits being made, and as the company's goal with the audit is the report and not the identification of possible improvements, there is a very low implementation rate of identified measures.

It was also mentioned in the interviews that the employees working in the production, spend a lot of time just getting the machinery to run, and thus might not be as focused on getting it to run optimally. Unstable electricity supply was also mentioned as a barrier.

Lastly, any energy improving initiative that requires importing of new equipment is not economically feasible for the companies, due to the relative weakness of the Ethiopian Birr to other currencies and due to import restrictions.

*Drivers*

An important driver is launch of the PEA certification scheme for energy auditors and as part of the 'Energy Regulation', establishment of a mandatory energy audit scheme that includes the implementation of certain energy efficiency measures for selected industries. To become a success, this should be supported by creating a market for commercial energy audits.

As most of the identified energy efficiency measures identified during energy audits require no or low investments according to the interviewed energy auditor, there is a high potential for saving energy without putting an economic burden on the companies. Creating awareness of the fact that the main cost is the staff resources for implementing the measures would make the EE projects feasible also when the electricity price is low. This can also prepare the companies for future tariff increases.

It is at the same time important that the top management of the companies becomes informed as to the benefits of conducting energy audits and implementing the identified energy saving measures. The energy auditing and energy management activities by the larger international companies setting up facilities in Ethiopia may push the Ethiopian owned and operated companies to follow them in order not to lose market shares.

### 5.1.2 Industrial cooling

*Impacts*

It has been informed to the review team that the Ethiopian government is assessing the possibility of creating large scale agro-industrial parks. These would require a large amount of cooling to store and preserve perishable goods. Correct factory and system design as well as good energy management can help create a more efficient and resilient industry and minimize the demand for energy. It is also important to look at the entire 'cold chain' which encompasses all the actions needed to bring perishable goods from production to the end consumer.

It is important also to secure the use of low impact refrigerants in the cooling sector as Ethiopia has many sectors where cooling is crucial, for example in meat processing, vegetable oil production and vaccine storage. In terms of refrigerants that can be used in cooling systems, Ethiopia has signed the Kigali protocol and is trying to phase out high global warming impact refrigerants as part of their Nationally Determined Contribution (NDC).

*Barriers*

In order to plan, design and build energy efficient agro-industrial facilities, the Ethiopian government needs competence-building and assistance from foreign experts because this would probably not be available locally. Building the facilities would also require import of high-quality equipment, which might become economically challenging. When the facilities are completed, there is a continuous need for training and

competence-building in order to ensure that the facilities are maintained correctly and continue to be run optimally.

*Drivers*

A larger domestic food production and processing industry would help to increase food security and likely reduce the cost of the produced foods, as the import of products must be expected to entail an increased cost to the consumer. Incorporating energy efficiency into the design and construction of the facilities from the beginning can ensure that the systems work optimally and that the cooling facilities are resistant to shorter periods of electricity supply loss.

This could be in the form of sufficient insulation to minimize heat intrusion in the cooling facilities and thus maintaining low temperatures for longer periods of time even in the event of a power failure. One place to look for knowledge and technical assistance is the 'Africa Centre of Excellence for Sustainable Cooling and Cold-Chain (ACES)[46]. MEPS for cooling equipment may in the longer term also be an efficient driver.

A driver to consider is a legislative requirement on a certain level of energy efficiency for product sites in new established agro-industrial parks.

### 5.1.3 MEPS for electric motors

*Impacts*

Correctly implemented MEPS will ensure that all products in scope put on the market will comply with the requirements. Often, the compliance of the MEPS requirements would only increase the product price marginally, while the economic benefit over the lifetime is substantially, especially if the future tariff increases will be adopted as planned.

*Barriers*

A main barrier is the availability and price of the complying electric motors, which typically should be imported. However, the saving potential would be very important and a solution should be sought for this issue.

Another barrier is a general MEPS barrier, which is the resources required to adopt and implement the scheme including market surveillance, laboratory testing, actions towards non-compliance etc.

*Drivers*

For MEPS for electric motors, there are many international experiences and schemes that can be copied or provide inspiration for an Ethiopian scheme. For example, the EU ecodesign requirements for electric motors and the United for Efficiency (U4E) developed 'Model Regulation Guidelines for Energy Efficiency requirement for General Purpose Electric Motors'[47].

Another driver for the companies is that they will be future-proof in terms of tariff increases and customer demands for energy efficient productions.

## 5.2 Households

For the households, two main measures have been selected for analysis:

- Appliances
- Lighting

[46] coolingafrica.org
[47] Model Regulation Guidelines for Energy-Efficiency Requirements for General Purpose Electric Motors - United for Efficiency (united4efficiency.org)

### 5.2.1 Appliances

*Impacts*

Based on interviews with users of the appliances the following use patterns have been estimated:

- Injera Mitad: This appliance has two uses, making injera and baking bread. It is estimated that it is used 2 times a week, for 1.5 hours at a time to make injera and approximately 2 times a week for 30 minutes to make bread. The injera is made in batches. This is similar to the use patterns identified in the DANAS report[48].
- Electrical stoves: Used to reheat food and to make tea. It is used 2 times each day for approximately 15 minutes to reheat food and 15 minutes each day to make tea.
- Fridge: Fridges are generally small and used to store things like meat and butter.
- TV: Generally small flat screen TVs, which are on most of the day – estimated 10 hours.

Table 7 presents an overview table of a typical electricity consumption calculated by the review team based on input from the interviews summarised in the following assumptions:

- Injera mitad: Maximum electric load of 3.5-3.9 kW[49] and an average load half of maximum, 4 hours per week
- Electric stove: About 1.1 kW, 45 minutes per day
- Fridge: 75 litres, double energy consumption of an F labelled fridge of the same size in the EU.
- TV: 26'' double energy consumption of a G labelled appliance in EU.
- Lighting: 45 W, 5 hours per day
- Other: Chargers etc.

*Table 7. Estimated typical electricity consumption in a household of 6 people.*

| Appliance | Annual energy consumption (kWh/y) |
|---|---|
| Injera Mitad | 380 |
| Electric stove | 300 |
| Fridge | 120 |
| TV | 230 |
| Lighting | 80 |
| Other | 20 |
| **Total** | **1130** |

From the table above it can be seen that the injera mitad and the electrical stove have the largest electricity consumption. Prototype injera mitads have been made, which are claimed to use 50% less electricity[50]. They use a different design with better insulation, less peak power (1.6-2 kW instead of 3.5 to 4 kW) and have a more efficient control (digital control). There are also types which use induction heating instead of electric resistance heating. All in all, there are a number of ways to optimise the energy efficiency and to make injera with less energy. There are also mitads on the market with digital control and lower wattage (1600 W, 16" diameter), which claims to be more efficient than the traditional mitad.[51]

Similarly for the other appliances, achieving a 50% reduction in electricity use by switching to more energy efficient products is reasonable to assume. Thus, a total annual electricity saving of around 500 kWh for a household of 6 people.

[48] DANAS, 2015. Project document on electric Injera Mitad. Energy efficiency standards and labelling.
[49] Energy consumption performance analysis of electrical mitad at Mekelle City | Momona Ethiopian Journal of Science (ajol.info)
[50] Enat Mitad | Revolutionizing Injera baking in Ethiopia
[51] https://www.amazon.com/Addis-Non-Stick-Smart-Griddle-Mogogo/dp/B07PQF8FBY

*Barriers*

One of the major barriers when it comes to promoting energy efficient appliances on the Ethiopian market is low awareness and a large informal market, where products are traded without the buyer being able to choose products based on the energy efficiency.

With the exception of the traditional injera mitad, the household appliances are not produced in Ethiopia.

*Drivers*

Efforts to create labelling schemes and MEPS for various appliances are currently ongoing in multiple countries and regions in Africa, which also has started in Ethiopia. Import of appliances from other countries using MEPS and labelling schemes would typically result in the imported appliances being compliant with the schemes unless the manufacturers export the non-complying products.

The schemes in other African countries could also act either as inspiration for Ethiopian legislation, or could become an area for new intergovernmental collaborations between Ethiopia and other African countries. Ethiopia is already part of the IGAD who have made a Regional Climate Change Strategy and Action Plan from 2023 to 2030 and is also part of COMESA and RAERESA which could act as good platforms for further collaboration in this area.

The injera mitad is seen as a product that would have the best opportunities and highest energy efficiency potential. It is a locally produced product and only used in a few other countries. Thus, any well enforced regulation on MEPS for injera mitads could have a high impact on the market. It should be supported with awareness activities to increase the demand for efficient mitads.

For other household appliances, and while the informal market and almost complete reliance on imports of electrical appliances raise questions about the potential impact of measures for these, support could be provided in defining suitable MEPS for individual products that are relevant at international level.

By basing any requirements on international IEC or ISO standards, exporters wishing to sell their products on the Ethiopian market would not find national requirements to be a barrier to the sale of energy efficient products, while at the same time they would understand which products should not be exported to Ethiopia, because they are too inefficient.

While support can be provided for Ethiopian level requirements, in order to have a greater impact, send a stronger market signal and be implemented with less effort, it is recommended that any requirements for Ethiopia be the same as for surrounding countries – this would require dialogue with relevant representatives of neighbouring countries.

### 5.2.2 Lighting

*Impacts*

A good LED[52] saves about 25% electricity compared to CFL[52,53]. Furthermore, the expected lifetime is around 2.5 times longer or even more. However, there is a big difference in the quality of various LEDs and the energy performance and lifetime is greatly affected by the temperature they operate in and the quality of the installed heat sink. Thus, while there is a large energy savings potential in shifting to LEDs, it is important that it is done with a focus on good quality LEDs.

[52] Learn About LED Lighting | ENERGY STAR
[53] Learn about CFLs | ENERGY STAR

Lighting is relevant area for household energy efficiency because there are already efficient LEDs on the market and the cost of an efficient product compared to a less efficient product is not very large, compared to the situation of other household appliances.

*Barriers*
Lighting is facing similar barriers as the other appliances, with a large informal market, import of cheaper and low-quality products, and no national production of the product. A barrier is low knowledge and awareness of the difference between LEDs and other lighting products.

*Drivers*
A main driver is higher quality light of LEDs compared to CFLs, a longer lifetime and lower electricity consumption.

For the Government, an important driver is the global interest, expressed in the Minamata Convention[54], to move away from the use of mercury containing products, as it is connected to severe human health and environmental effects. Initially, compact fluorescent lights were exempted from this phase-out, but in the first half of 2021 the African delegation submitted an amendment (The African Lighting Amendment), calling for a total phase out of all fluorescent lighting by 2025[55]. If it is adopted at COP28, happening in November-December 2023, it will effectively end the manufacture and trade of all fluorescent bulbs globally by 2026.

Many African countries have already begun the shift towards LEDs, with a good example of this being the EELA project in the EAC and SADC regions.

## 5.3 Buildings

*Impact*
A voluntary sustainability certification for buildings in Ethiopia was mentioned by one of the interviewees. Depending on how well-developed such an idea is, there is the potential to take inspiration from any number of green building certification schemes available worldwide and adapt their requirements to the Ethiopian context. The certification could focus purely on energy (simpler option) or also consider other aspects such as embedded energy in the construction materials, water, wastewater, noise, natural light, indoor air quality, thermal comfort and management factors.

This would probably be most suitable in the medium to long term, however, requirements may be introduced gradually starting with the low hanging fruits.

*Barriers*
It would require many resources to develop, adopt and introduce the schemes in Ethiopia and ensure that the complete construction sector would be able to comply with the requirements.

*Drivers*
Thanks to the long experience of energy efficiency in buildings in the EU, technical support could be provided for the development of any energy efficiency certification scheme for Ethiopian buildings and help with the development of an implementation strategy, potentially including training of certified assessors. Such a scheme could have different levels of complexity, with a bronze-silver-gold-platinum style approach like the LEED scheme, and could be focused only on a limited number of building types at first (e.g. hotels, government offices etc.).

[54] Homepage | Minamata Convention on Mercury (mercuryconvention.org)
[55] Africa Region Galvanizes Efforts to End Mercury Lighting - CLASP

## 5.4 Electricity distribution

For electricity distribution, two main measures have been selected for analysis:

- Distribution transformers
- Security of electricity supply

### 5.4.1 Distribution transformers

*Impacts*

From the interview with the EEU, energy efficiency in the electricity distribution does not appear to have previously been an area of concern. It was also brought forth that EEU needs knowledge on how to create an energy efficient distribution infrastructure and on how to determine the level of energy efficiency for equipment, in order to factor energy efficiency in when expanding the infrastructure. Based on this it can be assumed that the energy efficiency of the Ethiopian electricity infrastructure is likely not better than that of other countries in the region. Research done as part of the Green Climate Fund's Readiness Project in Botswana found that around 30% of electricity loss in the distribution system was due to poor quality electricity distribution transformers. An electricity savings potential of a similar size would be expected in Ethiopia.

*Barriers*

The current lack of knowledge and focus on energy efficiency in this area would require efforts to increase awareness and build up competencies. The energy efficient distribution transformers would also have to be imported, and thus there might be an economic barrier.

Furthermore, when human and financial resources are scarce, it may be a difficult choice of prioritising between energy efficiency and expansion of the grid to currently non-electrified areas. Naturally, it should preferable not be a choice between these two goals, however, in practice it may become the reality.

*Drivers*

As only 35% of households are currently connected to the national grid, there is a great opportunity to install energy efficient equipment as the electricity distribution infrastructure is expanded. This will require establishing purchasing requirements for the distribution transformers and design of digital solutions for monitoring the complete distribution system including the metering and customer payment e.g. via smart meters.

Work is already being done in other regions of Africa, such as Botswana, to establish MEPS for electricity distribution transformers and the U4E (United for Efficiency) has created 'Model Regulation Guidelines for Energy Performance Requirements for Distribution Transformers[56].

### 5.4.2 Security of electricity supply

*Impacts*

In order to incentivise private costumers to shift to electrical appliances and industries to electrify their processes, it is crucial to be able to secure a high degree of electricity security. Currently, the electricity security is found to be low, mainly due to an outdated distribution network prone to failure.

In the study 'Ethiopia: eCooking market assessment'[57] it is estimated that power is only available to end-users 81% of the time, which strengthens the picture of an electricity supply associated with low availability. This is calculated by multiplying the 'System Average Interruption Duration Index' (SAIDI),

[56] Model Regulation Guidelines for Energy Performance Requirements for Distribution Transformers - United for Efficiency (united4efficiency.org)
[57] https://mecs.org.uk/?s=Ethiopia+eCooking+Market+Assessment

which is an estimate of the average amount of hours that end-users are without power each time there is a power interruption and multiply this with the 'System Average Interruption Frequency Index' (SAIFI, which is an estimate of the how the average end user experiences power supply interruptions. EEU statistics for more than 5,000 larger customers with a smart meter, also showed that in March 2023, they experienced an average of 42 power cuts with a total duration of 23 hours (3.5% of the time).

*Barriers*

A large part of the current distribution network needs to be modernized and currently there is a larger focus from the EEU on increasing the electricity coverage, than on improving the existing infrastructure. This is also very resource intensive, both regarding financial funds and human resources.

*Drivers*

EEU is aware of the issue and its importance and Ethiopia is currently working with the World Bank to improve the reliability of the distribution network in regional cities and in the capital.

Modelling and forecasting the electricity infrastructure regarding needs and future electricity consumption facilitate the selection of areas for electrification for optimisation of the quality of the electricity supply.

It is furthermore an area which has a large focus in many emerging economies and there are much experience and solutions available. MEPS are available e.g. also in the European Union in the form of ecodesign requirements.

## 5.5 Awareness and training

For awareness and training, two main measures have been selected for analysis:

- Government
- Industry
- Households and retailers

### 5.5.1 Government

*Impacts*

Awareness and knowledge at the government level are important areas for establishing and carrying out an energy efficiency strategy. The interviews revealed that there is a need for increasing the awareness and knowledge both for the politicians and the government administrative staff.

At the policy maker level, there is a need to be aware of the potentials and benefits of energy efficiency and the measures that need to be in place in order to release the potentials. This relates to legislation and instruments to ensure compliance of the laws, e.g. regarding MEPS and energy labelling, standards, import regulations, market surveillance, market demands etc. need to be in ensured.

At the government administration level, the institutional strength of the implementing bodies is limited (with regards to e.g. funding, staff). Training is needed among others for transfer of international experiences, both from the African continent and from outside Africa, including the European Union.

Eventually, this may also attract financial funds from donors for the energy efficiency strategy, when all the human resources, legislation, instruments, practises etc. are in place to effectively use these funds.

Awareness creation and training would be a continuous effort that will ensure that the goals established in the energy efficiency strategy can be reached.

*Barriers*

A main barrier is that typically government institutions are understaffed, and it can be difficult to remove staff from their day-to-day tasks to training activities.

Next is that there is a risk of a higher rate of replacement of staff when trained people are offered positions in the private sector. Even though it is loss for the government institutions, often it may still benefit the energy efficiency area, when trained staff are working towards the same targets, just in the private sector.

*Drivers*

Staff would typically be very interested in increasing the knowledge level, especially if it can be part of a formal training activity e.g., where certificates are given for staff haven gone through the training and exams.

Training activities may also attract people to work in government institutions and increase the awareness level of the energy efficiency theme.

### 5.5.2 Industry

*Impacts*

The government needs to create awareness within the top management of the industrial companies in order that they become informed as to the benefits of conducting energy audits and implementing the identified energy saving measures. Next is that regulations, incentives etc. are developed to push them to conduct energy audits and implement main identified improvements.

Training of management and staff in what are ISO 50001 Energy Management Systems and then requiring these systems to be implemented in order for government permits for the industrial activity to continue to be granted would be one way of delivering on what is foreseen in Articles 49 to 54 of the Energy Regulation (No. 447/2019).

*Barriers*

Main barrier is to have the industry management listening to the arguments for why they should be more aware of energy efficiency in a situation where the energy purchase in most industry sectors does not constitute a large part of their costs.

*Drivers*

The arguments from the government side on why carry out energy efficiency activities should be very clear and persistent and preferable be communicated directly from top level of the government to the most relevant industry leaders via round table meetings, partnership agreements, etc. This could be combined with press coverage and public communication, which could be an important incentive for the industry leaders.

In cases where international companies and Ethiopian companies are working in the same sector, the best practice examples of the international companies could be used to serve as learning opportunities for the Ethiopian companies. This could be facilitated by workshops and site visits arranged by a third party and, if not voluntary, this activity could be made obligatory if the government made it conditional to the ongoing renewal of industrial permits for the companies (both international and Ethiopian).

Even though some principles are cross-cutting, training should be sector specific and prioritise the most energy intensive industries first. Sector-specific training maximises the meaningfulness of the training and the likelihood of new knowledge leading to energy savings in real life.

### 5.5.3 Households and retailers

*Impacts*

The household sector can be more difficult to target due to being more diversified and have different reasons for not taking energy efficiency into account when purchasing and using household equipment. Therefore, information and awareness creation will be needed in order to increase the energy efficiency level in the household sector.

The best way of doing it will be through targeted and very specific campaigns covering both the households and retailers. By this, both the demand and the supply side will be covered at the same time. Successful campaigns should always be very specific in terms of actions the target group should do and why they should do it, such as buying a good quality LED instead of a CFL because it will be cheapest in the long run, replacement is not needed for the next many years and the light quality is high.

The retailers should be made aware of the coming campaign activity e.g. in order that they have the LEDs in stock, they know why an LED is better than a CFL, and that they can guide the customer in the choice of light bulb.

The communication channels should be selected on the basis of where households are present via off- and online media.

Through actions and good experiences when buying efficient products, higher awareness will then be achieved which can aim activities towards other products such as efficient injera mitads.

*Barriers*

Main barriers include low income, low knowledge level, no availability of efficient products, no guidance from the point of sales etc.

*Drivers*

Main drivers include better and more durable products, which in the long term reduce the electric bill.

# 6 Recommendations

## 6.1 Overall recommendations

The recommended approach is to focus on initiatives that can be implemented in the short term with a dual aim: to achieve experiences for further development of energy efficiency activities; and to have showcases for policy makers and target groups to demonstrate that it is possible to get results.

The initiatives include a mix of voluntary and mandatory measures including legislation; market initiatives for suppliers and retailers; technical measures; and awareness and training towards all target groups and involved parties.

The industry and the household sectors will be the main sectors to target both in the short and longer term because these two sectors are responsible for about 80% of the total national electricity consumption. Activities here should be complemented with awareness and training activities. In the medium and long term, activities towards existing and new buildings should also be established. Optimisation and improvement of the electricity distribution are also important due to the ongoing electrification activities.

In the following, we provide specific recommendations for the selected five areas:

- Industry: Energy audits and energy management; industrial cooling; and MEPS for electric motors
- Households: Lighting and appliances
- Awareness and training: Government; industry; and households and retailers
- Buildings: Energy audits and energy management; and building certification scheme for new constructions
- Electricity distribution: Distribution transformers; and security of electricity supply

For details on impact, barriers and drivers, we refer to the previous analysis section.

The recommendations provided in the following are intended to be fully complied with for each subarea, e.g. all the points under “Industry - Energy audits and energy management” to obtain the best impact. The order of the areas and subareas under each area is ranked in terms of timely priority based on the assumed importance and complexity for implementing them. Only exception is the area of awareness and training, which is recommended to be implemented in parallel with the other activities.

## 6.2 Industry

### 6.2.1 Energy audits and energy management

Recommendations:

- Promote voluntary energy audits and establishment of energy management systems in the industry based on the experiences gained by current audit activities under PEA
- Establish a mandatory energy audit scheme under the Energy Regulation that includes the implementation of certain energy efficiency measures for selected large energy consuming industrial facilities
- Continue the PEA certification scheme for energy auditors and further develop where necessary
- Support creation of a market for commercial energy audits through incentives and awareness activities (see also section 6.4.2)

### 6.2.2 Industrial cooling

Recommendations:

- Assess further the Government plans for creating large scale agro-industrial parks and opportunities in the legislative framework for establishing energy efficiency requirements for the parks including voluntary agreements and mandatory criteria
- Review best practice in the cooling sector internationally (within Africa e.g. Africa Centre of Excellence for Sustainable Cooling and Cold-Chain and abroad), including EE for cooling components, passive building design concepts (e.g. insulation, solar shading and thermal mass) that could be used in factories and warehouses and low GWP (Global Warming Potential) impact refrigerants
- Develop, adopt and implement the scheme

### 6.2.3 MEPS for electric motors

Recommendations:

- Provide technical assistance for finalisation of the ratification of the MEPS for electric motors. See also section 3.2.4.
- Establish the supporting instruments for the MEPS scheme including market surveillance, laboratory testing, actions towards non-compliance etc.
- Support with market initiatives to stimulate the supply and demand of compliant electric motors

## 6.3 Households

### 6.3.1 Lighting

Recommendations:

- To investigate how the market for lighting products works in Ethiopia regarding the supply chain, mainly regarding importers and detail sector, and regarding consumers lighting preferences.
- Support with market initiatives to stimulate the supply and demand for long-lasting and efficient LEDs, based in the market investigations, through campaigning and awareness activities, see also section 6.4.3.
- Longer term: Use experiences with the market initiatives to develop a Minimum Energy Performance Standard (MEPS) that can be applied to LED products put on the market that will ensure adequate quality LED products

### 6.3.2 Appliances

Recommendations:

- Focus on energy efficient injera mitad products
- Establish supporting instruments for MEPS for injera mitad scheme including market surveillance, laboratory testing, actions towards non-compliance etc.
- Support with market initiatives to stimulate the supply and demand of MEPS compliant injera mitad including communication and campaign activities to customers and relevant actors in the supply chain

## 6.4 Awareness and training

### 6.4.1 Government

Recommendations:

- Develop and carry out awareness raising activities targeted government policy makers on benefits of energy efficiency, legislation (MEPS, energy labelling, etc.), instruments to ensure compliance of the laws, e.g. standards, import regulations, market surveillance, etc.
- Carry out a training needs assessment for the government administration level regarding identification of institutions, subjects, staff etc.
- Develop and implement a pilot training scheme and collect experiences for revising the training scheme
- Initiate the full-scale training programme

### 6.4.2 Industry

Recommendations:

- Develop and carry out awareness raising activities targeted top management of the industrial companies regarding benefits of conducting energy audits and implementing the identified energy saving measures.
- Develop and carry out a pilot training scheme on ISO 50001 Energy Management Systems and collect experiences for revising the training scheme
- Initiate the full-scale training programme

### 6.4.3 Households and retailers

Recommendations:

- Develop and carry out a targeted and very specific campaign on lighting covering both the households and retailers and including use of appropriate off- and online media, see also section 6.3.1,

## 6.5 Buildings

### 6.5.1 Energy audits and energy management

Recommendations:

- Medium term: When experiences with the industrial energy audits have been achieved, develop and implement a similar energy audit scheme for buildings

### 6.5.2 Building certification scheme for new constructions

Recommendations:

- Long term: Develop based on international schemes and implement an energy efficiency building certification scheme for new constructions that may include other sustainability subjects

## 6.6 Electricity distribution

### 6.6.1 Distribution transformers

Recommendations:

- Develop and implement energy efficiency purchasing requirements for distribution transformers based on international standards and requirements
- Design of digital solutions for monitoring the complete distribution system including the metering and customer payment e.g. via smart meters

### 6.6.2 Security of electricity supply

Recommendations:

- Assess the needs for technical assistance on modelling and forecast of future electricity consumption and on selection of areas for electrification for optimisation of the quality of the electricity supply and selection of areas for grid renovation