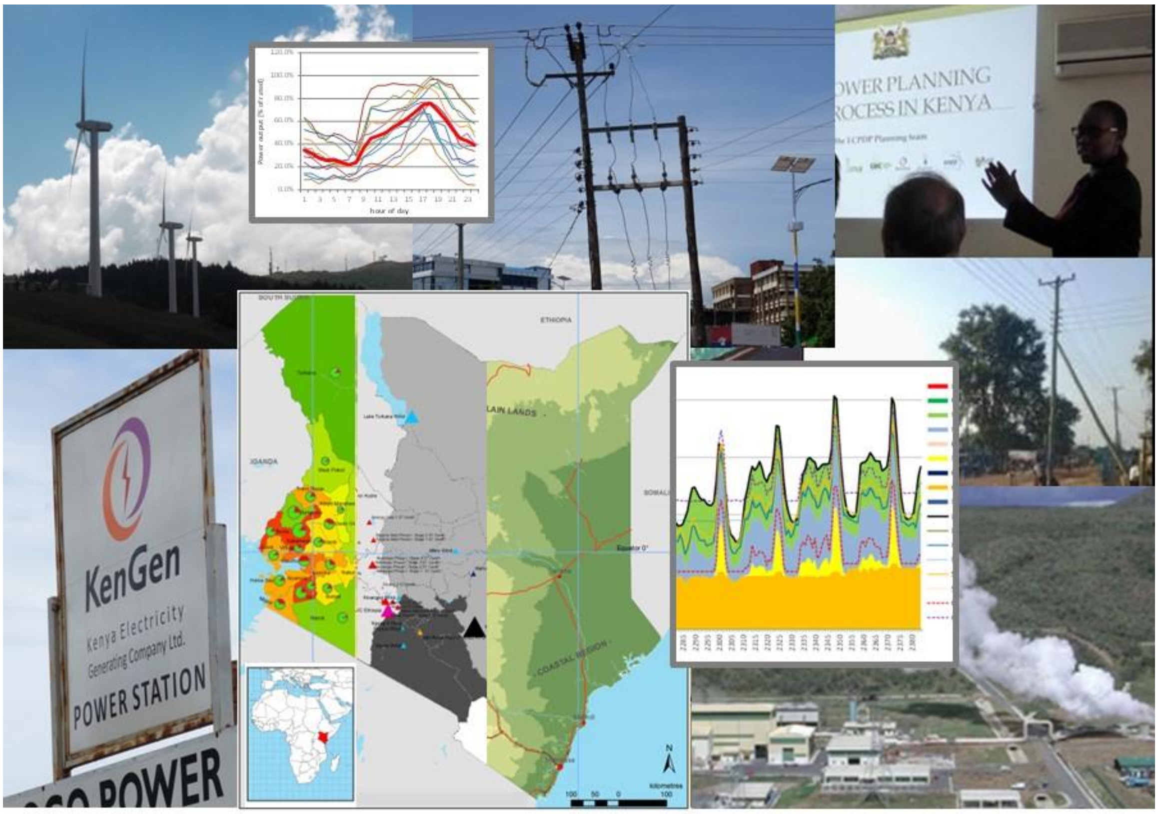
Final Report

Development of a Power Generation and Transmission Master Plan, Kenya

Long Term Plan – Energy Efficiency

2015 - 2035

October 2016



Ministry of Energy and Petroleum

Republic of Kenya

- The photo on the title page shows a collection of photos from power generation and network assets in Kenya and figures from the planning process

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Long Term Plan – Energy Efficiency

2015 – 2035

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Prepared for:

Ministry of Energy and Petroleum

Nyayo House, Kenyatta Avenue, P.O. Box 30582,
Nairobi, Kenya

Prepared by:

Lahmeyer International GmbH

Friedberger Str. 173
61118 Bad Vilbel, Germany

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Abbreviations and Acronyms

A/C	Air Conditioning
ABESCO	Association of Brazilian Energy Service Company
AC	Alternating Current
AEPEA	Association of Energy Professionals Eastern Africa
AFD	Agence Française de Développement
BOOT	Build Own Operate Transfer
BPT	Best Practice Technology
CB	Circuit Breaker
CDM	Clean Development Mechanism
CEEC	Centre for Energy Efficiency and Conservation
CER	Certified Emission Reduction
CFL	Compact Fluorescent Lamp
CIPA	Climate Change Investment Program for Africa
DANIDA	Danish International Development Agency
DSM	Demand Side Management
EDF	Electricité de France
EE	Energy Efficiency
EECA	Energy Efficiency and Conservation Agency
EEI	Energy Efficiency Index
EJP	Effacement Jour de Pointe (EDF tariff)
EPC	Engineering, Procurement and Construction
ERC	Energy Regulation Commission
ESCO	Energy Service Company
EU	European Union
FICCF	Finance Innovation for Climate Change Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GW	Gigawatt
GWh	Giga Watt-hour
HPS	High Pressure Sodium
HVAC	Heating, Ventilation and Air Conditioning
ICL	Incandescent Lamp
ICT	Information and Communication Technology
ICPEEB	Indian Council for the Promotion of Energy Efficiency Business
IDO	Industrial Diesel Oil
IED	Innovation Energie Développement
IFC	International Finance Corporation
IFI	International Financial Institutions
IGO	Intergovernmental Organisation
IISD	International Institute for Sustainable Development
IR	Inception Report

IRR	Internal Rate of Return
ISO	International Organisation for Standardization
ITP	International Test Procedures
KAM	Kenya Association of Manufacturers
KES	Kenyan Shilling
KETRACO	Kenya Transmission Company
KIRDI	Kenya Industrial Research Development Institute
km	kilometre
km3	cubic kilometre
KPLC	Kenya Power and Lighting Company
kV	kilo Volt
kVAR	Kilo volt ampere reactive
kW	Kilowatt
kWh	kilowatt-hour
LCPDP	Least Cost Power Development Plan
LED	Light Emitting Diode
LI	Lahmeyer International GmbH
LPG	Liquefied Petroleum Gas
LTP	Long Term Plan
LV	Low Voltage
m	meter
MEPS	Minimum Energy Performance Standards
MOEP	Ministry of Energy and Petroleum
MTP	Medium Term Plan
MV	Medium Voltage
MW	Mega Watt (10^6 Watts)
MWh	Megawatt Hours
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
NRG International	Energy International
NPV	Net Present Value
PGTMP	Power Generation and Transmission Master Plan
RE	Renewable Energy
RfP	Request for Proposal
RISE	Readiness for Investment in Sustainable Energy
RTE	Réseau de Transport d'Electricité
SAAE	South African Association of ESCOs
SSM	Supply Side Management
SWH	Solar Water Heater
TSO	Transmission System Operator
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization

1 EXECUTIVE SUMMARY

In 2013, the Ministry of Energy and Petroleum (MOEP) contracted Lahmeyer International (LI) to provide consultancy services for the development of the Power Generation and Transmission Master Plan (PGTMP) for the Republic of Kenya.

This report provides the Energy Efficiency (EE) component of the respective Long Term Plan (LTP) for the period 2015 (base year) to 2035.

1.1 Great EE potential

The following table summarises the accumulated energy savings potential[1] in each main activity subsector for the next twenty years. The figures reflect the difference between subsector consumption with current equipment and behaviour, and estimated consumption with the adoption of recommended regulations and measures. It must be understood that the savings obtained in any year are repeated all the following years. If these savings come true, the mentioned accumulated savings can be subtracted from the standard forecast consumptions and peak power every year.

Table 1-1: Accumulated energy savings potential[1] in each main activity subsector for the next twenty years

Subsector	unit	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Residential	GWh	0	0	0	66	136	212	292	378	470	567
Industrial	GWh	0	0	0	147	297	451	567	689	815	927
Commercial / institutional	GWh	0	0	0	195	409	624	763	904	1,046	1,151
Total savings	GWh	0	0	0	408	842	1,287	1,623	1,971	2,331	2,644
Savings share[1]	%	0%	0%	0%	4%	8%	11%	13%	15%	16%	18%
Peak power savings[1]	MW	0	0	0	87	179	274	347	423	502	572

Subsector	unit	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Residential	GWh	670	780	897	1,021	1,153	1,292	1,441	1,599	1,768	1,948
Industrial	GWh	1,044	1,168	1,337	1,514	1,699	1,893	2,095	2,308	2,531	2,766
Commercial / institutional	GWh	1,257	1,366	1,463	1,559	1,659	1,765	1,875	1,992	2,095	2,198
Total savings	GWh	2,971	3,313	3,697	4,094	4,511	4,950	5,412	5,900	6,395	6,911
Savings share[1]	%	19%	19%	20%	21%	22%	23%	23%	24%	24%	25%
Peak power savings[1]	MW	644	721	805	893	985	1,083	1,185	1,293	1,404	1,519

By 2035, some 25% energy savings can be achieved and 1,500 MW can be shaved off peak power demand if the necessary measures are implemented. The graph below shows that the residential

[1] Energy saving potentials are estimates on billed consumption level (i.e. potential additional savings on transmission losses are not included) compared to Reference Demand Scenario; peak power savings on power plant sent-out level (i.e. including savings on losses)

and industrial share of expected savings increases over the years while the commercial share decreases, although all categories of savings increase in absolute value.

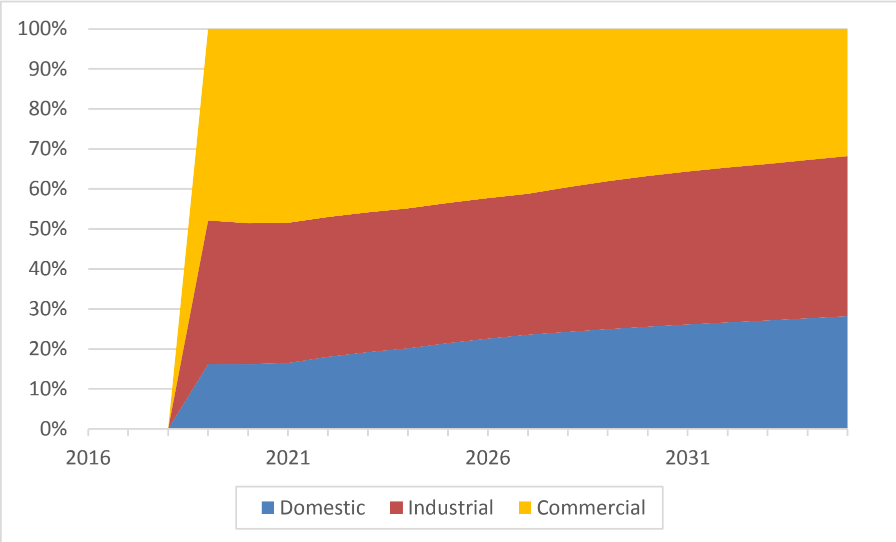

Figure 1-1: Subsector saving share 2016 - 2035

1.2 A mixed background

It is well known that energy efficiency is the cheapest way to balance energy needs and resources. This should not be neglected in Kenya's master plan. EE measures are effective both to reduce energy costs and to increase gross national product by improving the country's competitiveness.

The Ministry of Energy and Petroleum has enacted ambitious regulations to expand the use of efficient appliances in all subsectors. The most significant measures include compulsory solar water heaters for high-income customers and the recently launched obligatory triennial energy audits for premises of large commercial, institutional and industrial customers. Many stakeholders are involved in EE management and programs. ERC, KPLC[2] and KAM are the most active agencies in EE promotion. They are seconded by donors for efficient lighting distribution (AFD), audit campaigns (DANIDA), financing initiatives (AFD, CIPA, FICCF), labelling of appliances (GEF) and training (UN Habitat).

Preliminary survey results among the very large industrial and commercial consumers in the country show a positive picture: 93% of the interviewed entities were audited for energy of which 89% carried out energy saving measures, half of them with energy savings as expected or even higher (half of measures were implemented in the field of lighting).

[2] Due to the structure of the KPLC core business (the supply of electricity to an increasing demand) there could be a conflict of interest with EE measures which solely reduce the electricity consumption.

Nonetheless, the current impact of EE remains moderate in Kenya as evaluated by RISE[3]. This is due to the scarcity of private financing, the near absence of ESCO (Energy Service Company) industry in the country and the still inadequate levels of commitment and awareness in the various subsectors.

1.3 Comparing existing and new EE potential

Profound transformations are occurring in all subsectors of the Kenyan economy. Electricity shortages and poor quality of supply have been persistent barriers to development for years. This constraint is about to be lifted. Social migration and large electrification programs offer opportunities to promote EE awareness and the adoption of efficient equipment and behaviour in the residential subsector, especially in the urban areas. The industrial subsector is also expected to undergo significant renewal and expansion. New businesses will have to comply with international best practice, and existing ones will be subjected to audit campaigns which should increase their energy efficiency. Similarly, the commercial/institutional subsector is expected to follow the trend towards positive energy building.

The above highlights the fact that the greatest EE potential lies with new actors. EE stakeholders should, thus, especially focus on these newcomers.

The forecast analysis of expected savings is based on the assumption that existing consumers comply with regulatory and recommended standards and that the new consumers immediately adopt international best practices.

1.4 Increasing the chances of success

Additional measures can be taken to increase the chances of capturing the expected savings:

- Preliminary checks for new customers,
- Prohibition of instantaneous water heaters,
- Calibration of new LV services,
- Improvement of KAM audit practices and transparency,
- Dissociating credit lines and management teams for renewable energy and energy efficiency,
- Development of the ESCO industry,
- Research on additional cogeneration opportunities,

[3] Source: World Bank, *Readiness for investment in Sustainable Energy, RISE survey* (2013)

DSM (Demand Side Management) is another option to mitigate the cost of electricity supply even though it is not, strictly speaking an energy efficiency measure. A wide array of tariffs could be proposed to all categories of customers to manage seasonal, time-of-day and intermittent generation so as to minimise the use of the most expensive generators.

A cost benefit analysis showed that the EE measures would lead to a reduction of the overall generation costs (including costs for EE measures) in the range of 6%. The ratio of benefits (generation cost reduction) and costs (for EE measures) is above 5. Obviously, the positive effect of EE measures is reduced if it coincides with excess energy in the system. In the simulation this is mainly the case during the period 2019 to 2025 where new large generation capacities are scheduled. If excess energy is lower (e.g. due to a delay of generation projects) the benefit cost ratio would increase.

2 INTRODUCTION

In 2013, the Ministry of Energy and Petroleum (MOEP, further also referred to as "the client") contracted Lahmeyer International (LI, further also referred to as "the consultant")[4] to provide consultancy services for the development of the Power Generation and Transmission Master Plan (PGTMP) for the Republic of Kenya.

This report provides the Energy Efficiency (EE) component of the Long Term Plan[5] (LTP) for the period 2015 (base year) to 2035.

This chapter includes the following sections:

- The objectives of the report (section 2.1)
- The structure of the report (section 2.2)
- Introduction to the methodology and assumptions (section 2.3)

Note: The results provided in this report are not statements of what will happen but of what might happen, given the described assumptions, input data and methodologies.

In particular, given the very high uncertainty of, for instance, the development of demand, its regional distribution and the economic and political framework the reader should carefully study the described assumptions before using any of the results.

Therefore, this critical review and regular update of the assumptions applied in this report is essential for any planning process based thereupon.

2.1 Objectives of report

The overall objective of the report is:

The identification and analysis of energy efficiency potential within the Kenyan power sector and respective suitable measures and recommendations to realize these measures (to contribute to the Power Generation and Transmission Master Plan – Long Term Plan).

[4] Lahmeyer International conducts this project with Innovation Energie Développement (IED), France.

[5] The LTP is the identification and analysis of suitable expansion paths of the Kenyan power system for that period, complying with the defined planning criteria and framework. That EE (and renewable energy) tasks are an integral part of the overall Master Plan (e.g. providing input for the demand forecast and generation optimisation). It was agreed with the client that these subjects will be considered as such, i.e. in practice as tasks of the Master Plan closely depending on the other Master Plan tasks. Hence, this report complements the PGTMP LTP report and vice versa.

This broad objective encompasses the following:

- To analyse past electricity demand by activity sector,
- To analyse suitable potential energy efficiency actions that could reduce growth in demand both for overall energy and peak power,
- To assess the expected contribution of such actions in mitigating demand,
- To analyse the institutional, economic and financial tools needed to implement the actions with a proposed schedule for implementation,
- To suggest additional EE measures.

These recommendations are meant to:

- Raise awareness of possible future developments,
- Provide guidance for monitoring actual development of the expansion plans with respect to energy efficiency,
- Mitigate risks and increase benefits.

Hence, even with the suitable expansion plan and energy efficiency measures and potential identified, the Client is strongly recommended to continuously assess and update the assumptions and change the schedule to take into account any unpredicted technological innovations and new actors in the energy sector.

2.2 Structure of report

This report consists of the following main sections:

1) **Executive summary**, summarising the main results and recommendations of the report;

2) **Introduction,** providing the report's objectives and structure, and a general overview of the approach and assumptions and tools applied;

3) **Background and Policy analysis**, providing an explanation of EE role in Kenya energy policy, EE enacted legal and regulatory framework, EE programmes and financing, the inventory of main EE stakeholders and available documents;

4) Evaluation of **EE potential in the residential sector**, establishing categories of residential customers, consumption of residential appliances, level of access, calculation of potential EE savings at existing and new consumers, and prediction of residential savings per annum.

5) Evaluation of **EE potential savings in the industrial sector**, providing power analysis of the industry sector in Kenya, analysis of industrial audits, categorization of industrial consumers, potential savings of industrial subsectors, potential savings of new industrial customers, and saving allocation per annum.

6) Evaluation of **EE potential in the commercial/institutional sectors**, providing power analysis of the commercial/institutional sector in Kenya, analysis of the energy audits, potential savings of the existing and new commercial/institutional customers, saving allocation per annum, and a brief on street lighting saving potential.

7) Evaluation of **costs and benefits of an energy efficiency savings scenario** within the generation expansion plan.

8) A summary of **main recommendations for EE** including a **logical framework and work plan**.

2.3 Methodology and assumptions

This chapter summarises the approach used for defining the EE measures and for evaluating their impact based on the assumptions listed below.

2.3.1 Methodology for calculating energy efficiency potential in power sector

The methodology consisted of the following steps:

- Inventory of current EE measures applied to existing and new customers,
- Analysis of existing domestic consumption per customer according to income and geographical location based on a statistical study of appliances and access,
- Calculation of the impact of current EE measures based on income and assumptions about increases in access,
- Analysis of the existing industrial consumption per activity sector based on KPLC data (sample of large consumers by subsector) and a sample of audits in subsectors,
- Calculation of the impact of EE regulatory measures on industrial consumption based on potential savings found in audits or in standardized data on the internet,
- Analysis of the existing commercial and institutional building consumption based on KPLC data (sample of large consumers by subsector) and a sample of audits in subsectors,
- Calculation of the impact of EE regulatory measures on commercial/institutional buildings based on potential savings found in audits,
- Proposal of additional EE measures that could be applied.

2.3.2 Assumptions for energy efficiency in the power sector

This chapter exclusively focuses on the assumptions made for calculating the impact of energy efficiency on the demand-side power sector in Kenya from today up to the year 2035.

Energy efficiency impact evaluation will separately concentrate on two targets:

- Existing 2013/2014[6] power consumptions,
- New consumptions which are due to appear as described in the paragraphs 0, 5.6, and 6.5.
- Energy efficiency is expected to take effect from 2019 onwards to leave lead up time for the design and implementation of measures. This is not differentiated by measure or sector.

As the demand forecast chapter demonstrates, the new consumptions will reduce the importance of today's consumptions in every scenario (e.g. about 50% new electricity consumption in 2020 compared to 2014). Consequently the measures and calculations specifically designed for the existing consumptions will be considered over a limited period of time stretching from now on to 2025. They will consist of corrective actions and impacts. New consumptions will be targeted by preventive actions mainly implemented at the design and commissioning steps.

The EE analysis is incorporated into the overall master plan through the electricity demand forecast with the following approach:

- It is assumed that the demand reference scenario will be based on the current energy/GDP ratio as it appears in the data collected for the residential, industrial and commercial power consumers. Consequently, it is assumed that the demand forecast model does not take into account any EE impact resulting from technological, regulatory or incentive trend or action in addition to the historic development, i.e. through measures suggested under this EE component.
- A sub-scenario to the reference demand scenario will incorporate energy efficiency assumptions into the calculations and will allow the later analysis of the impact.
- Actions that will not reduce the amount of electricity consumed on the demand side such as independent energy generation (renewable and cogeneration) and DSM are only generally dealt with in this section or partly considered in the power generation expansion chapters.
- The evaluation of the EE potentials is made on the basis of socio–economic and geographical categories for the residential customers and by subsectors for the industrial, commercial and institutional customers.
- Energy saving potentials are estimates made on billed consumption level (i.e. potential additional savings on transmission losses are not included). Peak power savings are estimates based on power plant sent-out level (i.e. including savings on losses).

[6] Financial year of latest available data on electricity consumption of large scale consumers.

3 BACKGROUND AND POLICY ANALYSIS

Kenya is a vastly growing economy with rapidly increasing electricity demand. Compared to power deficits in the past, the current levels of electricity generation are able to meet the demand. However this balance is still tight and the generation capacity is likely to be challenged in the future as a result of growing demand. Further, as the analysis of demand characteristics revealed there are challenges which go beyond the installed generation capacity only. These are bottlenecks to supply certain areas (e.g. Western power system area) and voltage levels in a secure and qualitative manner. Also it needs to be known whether the large evening peak require certain operational flexibility of the power generation capacity. Amid a large number of large intermittent wind power plants under construction the need for this flexibility will be also required from the supply side.

Against this background Energy efficiency (EE) is a useful tool

- In order to maintain the balance between supply and demand of electricity in the short and medium term. This is especially relevant for Kenya until the commissioning of new suitable production plants that can supply for instance the flagship projects which may also represent a part of the future demand increase.

- In terms of costs: as mentioned in the RfP, the cheapest energy is the energy which is not consumed, and thus not produced.

    - Implementation of EE opportunities is much cheaper than additional generating capacities. This is one of the most significant advantages of energy efficiency compared to renewable energy sources that produce energy but very often present little or no firm capacity i.e. wind, solar and even some hydro-plants, making thus necessary to double the investment for installing a capacity backup.

    - Fostering EE also mitigates losses in the supply system and when combined with demand side management (DSM) reduces the need for expensive peak generation.

The present EE component of the Power Generation and Transmission Master Plan aims[7] at

- Identifying the potential savings within the electricity consumption, not only to reduce the current consumption,

- But also to reduce in a sustainable way, the future uses resulting from new connections to the grid. This will create a lower growth rate of power demand for a given GDP growth.

In the previous LCPDP reports, EE has been only marginally taken into account. EE was considered as an implicit factor to moderate demand growth, not as a calculated tool in itself. In spite of previous KAM campaigns (from 1996) to audit large power consumers and expand EE expertise, very few implementation initiatives have materialized. Large users have long been focusing on the unre-

[7] According to the Request for Proposal (RfP)

liable electricity supply and rather investing in costly diesel generators to protect themselves against load shedding.

3.1 Key results and conclusions

The key results, corresponding conclusions and planning recommendations are:

- Energy efficiency has been a regular feature in Kenya energy policy for a number of years with World Bank supported programs in industry as early as 1995. However, the World Bank gave Kenya a “medium” score in its readiness index for developing EE.

- Kenya EE policy includes constraining regulatory measures as well as proactive actions. Key regulations impose the use of residential solar water heaters and have launched an ambitious periodical audit campaign of industrial and commercial premises, followed by compulsory savings. Incentives are based on labelling appliances and distributing efficient bulbs.

- A number of national and international organizations have launched and financially supported EE programs in the country. Nevertheless the ESCO (Energy Service Company) industry remains embryonic and financing is scarce.

- The energy sector might not be very supportive due to dynamic generation programs which push for increasing demand and competition with renewables, factors which may result in EE efforts being limited.

3.2 Legal framework

The legal framework of the energy sector is based on three main documents:

1) Kenya’s Energy Policy of 2004;

2) The Energy Act of 2006, which implements the energy policy and provides a framework for climate change mitigation, through energy efficiency and promotion of renewable energy;

3) The feed-in Tariffs policy of 2008 (revised 2012) that promotes generation of electricity from renewable sources.

The passing of the new Constitution of Kenya in 2010 led to a global revision of the energy sector framework which did not seem adequate to fulfil Kenya’s vision 2030.

Since 2012, a new energy policy has been developed by Kenya's Ministry of Energy and Petroleum and its final draft was available in 2015. The “National Energy and Petroleum Policy Draft” lists and phases 16 energy efficiency measures as follows:

Table 3-1: Policies and Strategies - Energy Efficiency and Conservation Implementation

	Policies and strategies - Energy Efficiency and Conservation
1.	Develop and implement sustainable, awareness and sensitization programmes on energy efficiency and conservation.
2.	Implement energy efficiency and conservation initiatives in all sectors.
3.	Develop and implement guidelines for carrying out of energy audits and advisory services in the counties.
4.	Develop and enforce minimum energy performance standards (MEPS) and rating labels for energy efficiency and conservation equipment.
5.	Develop and implement a regulatory framework to provide for incentives and penalties to reduce high losses in generation, transmission and distribution.
6.	Provide appropriate fiscal and other incentives to enhance uptake of energy optimization technologies.
7.	Build capacity and empower the energy efficiency and conservation directorate and establish an Energy Efficiency and Conservation Agency (EECA) to champion and spearhead energy efficiency and conservation activities.
8.	Enforce building codes to enhance the concept of green design in buildings.
9.	Develop and enforce standards for fuel economy of motor vehicle operations and maintenance practices.
10.	Promote safe and fuel efficient transportation for passengers and cargos.
11.	Adopt the use of new and efficient technologies in energy efficiency and conservation.
12.	Develop, disseminate and implement the National Energy Efficiency and Conservation Plan in consultation with relevant stakeholders.
13.	Undertake research and development in energy efficiency and conservation.
14.	Collaborate in the preparation of education curricula on energy efficiency and conservation.
15.	Implement international co-operation programmes in energy efficiency and conservation.
16.	Collaborate with the private sector in energy efficiency and conservation

Source: Draft National Energy and Petroleum Policy (January 2015, Republic of Kenya - Ministry of Energy and Petroleum)

This draft clearly shows that once the EE policy is in place and after the electricity production capacity is increased, EE would remain a significant part of any energy policy in Kenya. EE does not mean rationing the supply of electricity but rather promoting the rational use of this form of energy through increasing the efficiency in transport, distribution and end-use, which are critical for the improvement of the energy access in the whole country. In other words, what is more desirable is to create a disconnection on the long term between the economic growth, which by no means should be jeopardized, and the related level of energy consumption growth, which must be reduced. This policy shall increase the country's national energy security and lead to substantial savings through the limitation of imports. It shall also contribute to the country's economic growth since a number of manufacturing firms are claiming that electricity supply problems are constraining business. Furthermore, it will reduce the pressure on the supply side and allow more time for a rational planning of new generation, transmission and distribution capacities, while leading to substantial savings of investment costs.

3.3 Regulatory framework

As summarised by the following graph, the World Bank ranked Kenya energy efficiency performance as medium in the RISE (Readiness for investment in Sustainable Energy)[8]. More details are provided in Annex 3.A. Kenya's score is lower in EE sector than in Renewable Energy and Energy Access, confirming the general impression that in the recent years, EE has not been as high as the other two sectors on the energy policy agenda.

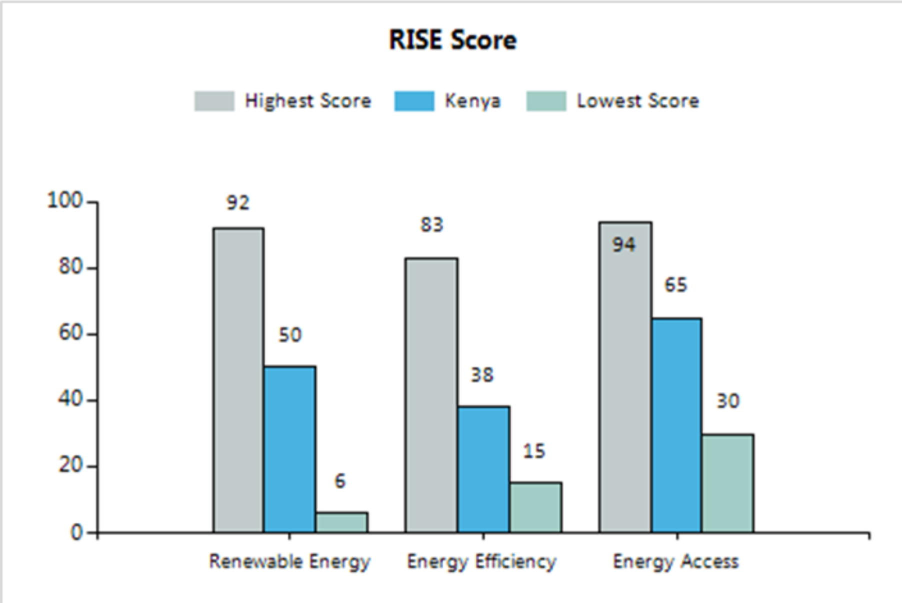

Figure 3-1: Scoring of Energy efficiency, Energy Access and Renewable[8]

However, two recently enacted regulatory powerful measures could improve that score:

1) Solar water heating regulation that requires owners of large premises (consumption greater than 100 litre per day) to install a solar water heater within a period of 5 years, and

2) EE regulation that forces large energy consumers to accept an energy audit every three year. Recommended actions relevant to capture half of the potential savings should then be fulfilled before the next audit is made.

Of course, the implementation of the first measure can prove to be difficult because of obvious feasibility and regulatory problems, unless it is endorsed by KPLC[2] as part of its connection and meter reading policy.

ERC calculated that the implementation of the second regulation would necessitate the recruitment and training of three hundred EE specialists for the large premises only, which requires a tremendous training effort. In addition, the technological, commercial and financial fluctuations of

[8] Source: World Bank, *Readiness for investment in Sustainable Energy, RISE survey* (2013)

the industrial sector over a three year period make monitoring difficult. Main excerpts from these regulations are provided in Annex 3.B.

The latest regulatory announcement by ERC with regard to energy efficiency designates all industrial, commercial and institutional energy users with a defined minimum energy consumption for a number of required actions (with a compliance deadline 28 September 2015):

1) "Formally designate an energy manager

4) Prepare and submit to the Commission an energy management policy for approval

5) Carry out an energy audit every three years

6) Submit audit reports and implementation plans to the Commission for approval

7) Commence implementation of energy-saving measures identified by the audits and accomplish at least 50% savings within a period of three years."[9]

At this stage, it is useful to mention the importance of final users undertaking energy efficiency actions on the demand side. This should be an inherent feature of any EE policy managed by governments, ministries and agencies. Regulations and incentives alone will not guarantee the proper installation and use of efficient equipment in an efficient way over a long period of time.

3.4 Energy efficiency programmes

This section briefly describes the main energy efficiency programs in Kenya.

1) KAM / Centre of Excellence for Energy Efficiency and Conservation (CEEC) Programme

Under KAM management, the main task of the CEEC in the framework of programmes financed by the MOEP and DANIDA[10] is to perform Energy Audits in large facilities in the industrial sector. These audits were extended to commercial and institutional facilities such as hotels, hospitals, commercial centres, universities, and office buildings.

CEEC is also in charge of other activities:

- The organization of trainings on Energy Efficiency: boilers and steam systems, air conditioning, heat and refrigeration,
- The assessment of the implementation of the recommendations as well as the impacts resulting from the energy audits.

[9] Source: ERC, Public Notice: The Energy (Energy Management) Regulations, 2012, http://www.erc.go.ke/index.php?option=com_content&view=article&id=249 (accessed: 1 October 2015)
[10] Danish International Development Agency

- Nearly 450[11] audits were realized to date. However, the amount of the detected EE potential was estimated at 45 MW, a surprisingly low figure.

2) Standard and labelling programme financed by the Global Environment Fund (GEF)

The main objective of the programme is to remove the barriers to rapid and widespread uptake of EE equipment and appliances (or technologies) at various levels. The table below summarizes the sectoral uptake and diffusion of EE technologies.

Table 3-2: EE programmes implemented or launched

Sector	EE technology
Residential	Refrigerators; lighting (CFL); air-conditioners
Commercial	Display refrigerators; air-conditioners; lighting (CFL)
Industrial	AC motors; lighting (CFL)

Source: Standard and labelling programme (GEF)

3) Replacement of incandescent lamps (ICLs) with Compact Fluorescent Lamps (CFLs)

In 2012, the Kenya Power and Lighting Company and the Ministry of Energy undertook a Clean Development Mechanism (CDM) efficient lighting project involving replacement of incandescent lamps (ICLs) with Compact Fluorescent Lamps (CFLs). KPLC entered into a partnership with the Standard Bank for development and purchase all of CERs from carbon asset projects identified in KPLC. Cool NRG International was hired by Standard Bank to elaborate the project design. The project aims at replacing (approximately) 1,250,000 ICLs with high quality CFLs in Kenyan households across Kenya, free of charge, in a manner compliant with the Green Light for Africa Small Scale Programme of Activities. So far, the programme has achieved the following impacts on power consumption:

- Peak demand reduction by 48 MW,
- Energy savings of up to 61,000 MWh per year,
- Energy cost savings KES 72 million per year,
- Reduction in fuel Costs KES 872 million per year,
- Avoided generation expansion worth KES 5 billion, and

[11] Up until 2014, some 250 Energy audits were undertaken on behalf of the Ministry of Energy and Petroleum in mainstream industries, small and medium enterprises (SMEs) and public institutions. Assistance from DANIDA to CEEC also permitted the completion of 150 further energy audits.

- Abated GHG emissions of 55,000 tons eq. CO_2 per year.

The programme was expanded to an extra 3,300,000 bulbs[12] started in 2013 under AFD financing with implementation planned for August 2015 to March 2016. Overall reduction of peak demand is estimated at 120 MW.

4) Association of Energy Professionals Eastern Africa (AEPEA)

AEPEA objectives focus on upgrading skills in energy management. The association objectives are the following:

- Uphold the highest standards of professionalism in energy management.
- To afford due consideration to and expression of opinion upon questions affecting the industry to hold meetings for the presentation and discussion of technical papers.
- To promote the scientific and educational interests of those engaged in the energy industry.
- To spearhead research in the field of energy efficiency, renewable energy and energy management
- To formulate Rules and Regulations to be adhered to by the members for purposes of attaining the stated objects of the Association

5) IFC's Climate Change Investment Program for Africa (CIPA).

CIPA's goal is to unlock vast unrealized potential for sustainable energy finance on the continent. It aims to do this by catalysing a market for investment in energy efficiency and renewable energy projects. CIPA provides combined advisory and investment services to financial institutions to help them enter a new lending market. Since access to finance is not the only precursory and enabling factor for investment in sustainable energy, CIPA also works on local capacity building and raising awareness as well as on policy engagement.

6) UN Habitat Programme

UN Habitat is going to launch a program for promoting energy efficiency in buildings in Eastern Africa: Kenya, Uganda, Rwanda, Burundi, and Tanzania. Based on the fact that 40% of the total electricity is used in urban buildings, this program aims to mainstream energy efficiency measures

[12] 1.65 million CFL of 13 - 15 W and 1.35 million of 20 to 23 W.

into housing policies, building codes and building practices in East Africa, and to reduce CO2 emissions.

7) KPLC own energy efficiency program

KPLC[2] is implementing its own EE programme that consists of particular measures on network retrofit and improvement, as well as measures to promote electricity demand management in line with the Energy Act and its amendment on large consumers.

The EE measures on the supply side are:

- Use of conductors with less resistance and reduction of the length of MV power lines,
- Building of more transmission substations and location of distribution transformers near the load centres. Construction of new lines and substations to cater for load growth,
- Ensure proper design of transmission lines to minimize corona losses, and
- Procure & Install low loss equipment (transformers).

The EE measures on the demand side are:

- Reduction of wasteful electricity consumption,
- Allow for more load growth with existing capacity,
- Optimise customer bills and reduce debt and associated disconnections,
- Improve quality of supply & customer satisfaction,
- Reduce losses on the supply side,
- Power Efficient Lighting program roll outs in residential sector,
- Promotion of Energy Efficiency initiatives in the country,
- Dissemination of energy efficiency and conservation information to customers,
- Provision of energy audits and energy advisory services to customers, and
- Smart Metering to assist customers in monitoring and managing energy usage.

8) AFD / EU SUNREF Programme

On July 2015 ERC organized a RE/EE conference. There, AFD / EU announced the second phase of the SUNREF program. The first phase covered energy efficiency projects in the textile and dairy industries and renewable energy projects. The program combines a financing instrument with technical assistance to prove that small and medium EE project are bankable. Eligibility criteria are defined such as maximum debt (less than 6,5 million USD), maximum investment (less than 13 million USD), innovative small and medium size projects in Renewable Energy or Energy Efficiency and an internal rate of return (IRR) between 8% and 50%.

9) Finance Innovation for Climate Change Fund

FICCF is the UK arm for climate change. As announced in the above mentioned Nairobi conference it focusses on financing EE/RE feasibility study and assess bankability of the projects.

10) Programmes outside of the power sector

Other actions out of the power sector include thermal efficiency at industry premises including third party investment to replace boilers and install biomass cogeneration, promotion of efficient cooking stoves and expansion of LPG (Liquefied Petroleum Gas) use instead of wood-fuel and charcoal.

3.5 Energy efficiency financing

The study has identified a number of barriers which presently hinder the smooth and straightforward financing of energy efficiency investments by the various economic actors: SMEs, households, public buildings, etc. Identified gaps and barriers for energy efficiency financing include:

- A general difficulty in the country to access finance from the institutional financial system. Such a hostile environment constitutes obviously an additional constraint for energy efficiency projects;
- A lack of understanding of the technical and economic issues related to energy efficiency investments, on both side (banks and energy consumers);
- A lack of availability and credibility of credit Information regarding projects promoters;
- A lack of reliable technical Information on energy efficiency equipment and technologies;
- A lack of competencies and interest within the banks as regards to project finance procedures and modalities;

- A preference by investors and banks for renewable energy projects every time a financing credit line includes both energy efficiency and renewable projects (which occurs quite frequently);
- A limited potential role of micro-finance institutions in that regard; and
- The nearly absence of an established ESCO (Energy Savings / Service Company) industry in the country (partly because of their specific risk for their capital and resulting limitations of financing),

As a result of these gaps and barriers, banks are more tempted to develop other kind of financial products (such as the financing of imports) than to allocate time and efforts to financing EE investments.

Nevertheless, an interesting financing scheme was observed with Lean Energy Solutions Company whose profile is attached in Annex 3.C. Lean is detaining a factory making briquette out of agriculture sub products. It proposes a BOOT (Build Own Operate Transfer) 7 to 10 year contract to thermal users by replacing their existing boilers by new ones using the briquettes. They retain half of the cost savings on fuel to recover the initial investment and maintenance. Although this mechanism is not in the scope of this study, it could easily be applied to power systems such as solar water heaters, motor and lighting replacement and installation of air conditioning systems. Although Lean is in control of the whole energy process of its customers, it is still difficult to obtain bank financing for the initial investment. Annex 8.A reviews international ESCO experience in developing countries.

3.6 Stakeholders and financing mechanisms

Stakeholders in energy efficiency in the power sector in Kenya can be split into four categories: Government bodies (Gov), Parastatal bodies (Par), Inter-governmental and non-governmental organizations (IGO and NGO), Business entities (Bus). The following table provide the names and the roles of the numerous stakeholders.

Table 3-3: List of stakeholders

Cat.	Stakeholder name	Roles and functions
Gov	Ministry of Energy and Petroleum (MOEP)	Energy policy, regulations, support for a centre on EE and conservation
Gov	Ministry of Environment and Natural Resources	Control of pollutant emissions
Gov	Ministry of Industrialization and Enterprise Development	Efficiency standards, labelling, education and awareness, certification compliance
Gov	Ministry of Planning, Local Authority	Compliance with SWH regulations, urban management
Gov	Ministry of Finance / National Treasury	Financial incentives, regulation

Cat.	Stakeholder name	Roles and functions
Gov	Energy Regulatory Commission (ERC)	Education and awareness, regulation, energy management, policy, finance, certification
Gov	Kenya Bureau of Standards	Certification and accreditation, labelling efficiency standards, policy, regulation
Gov	Kenya Industrial Research Development Institute (KIRDI)	Education and awareness, R&D, standards development, baseline studies
Gov	National Environment Management Authority (NEMA)	Enforcement of standards as part of statutory environmental audit. Standards development
Gov	Kenya Revenue Authority	Tax regime on energy products
Gov	Kenya Institute for Public Policy Research and Analysis (KIPPRA)	Undertake studies on energy use
Gov	Centre of Excellence for Energy Efficiency and Conservation	Audits and Training
Gov	Jomo Kenyatta University of Agriculture and Technology	Education and awareness, energy audits, labelling, R&D
IGO	United Nations Environment Program (UNEP)	Climate change Program
IGO	United Nations Development Program (UNDP)	Finance labelling program
IGO	UN Habitat	Promote energy efficiency in buildings
IGO	French Development Agency (AFD)	Finance EE/RE credit lines, efficient lighting, assistance to EE study
IGO	International Finance Corporation	Catalyse investment in EE/RE through Climate Change Investment Program
NGO	Global Village Energy Partnership	Kenya Climate Innovation Centre for businesses
Par	KETRACO	SSM, DSM
Bus	Kenya Power (KPLC)[2]	SSM and DSM programs
Bus	Kenya Association of Manufacturers (KAM)	Audits and training programmes
Bus	Lean Energy Limited	Audit and ESCO business
Bus	Various consultants	Provide audit services
Bus	Faulu microfinance and others	Micro finance credit lines with Standard Chartered Bank Kenya (12,5% IRR) and Deutsche Bank (6,5% IRR)
Bus	Consumer Information Network	Education, awareness
Bus	Suppliers and retailers of electrical appliances	Labelling, efficiency standards, education & awareness, energy audits, finance

3.7 Inventory of existing EE documents

Energy efficiency was the object of several recent previous studies or documents:

Table 3-4: Recent studies and documents on Energy Efficiency

Reference	Scope / focus
EGIS, Marc Bellanger- Report on Energy Efficiency (13-20 November 2010), AFD for the Ministry of Energy	This document is the only one to cover the whole spectrum of energy consumption. However, this report does not indicate quantitative results or objectives, while assessing that the potential for EE is large.
EGIS, Report on the household Survey for the total of Kenya First Draft (April 2013) and Nairobi household survey data (2012)	This document covers the household survey for Kenya conducted for the LCPDP in 2012 and 2013; detailing assumptions and results on the end-use / household appliances. Survey data for the Nairobi region are available.
MARGARET KANINI NZIA, End use based model for residential power consumption forecasting in Nairobi region-Thesis-Master of Science in Energy Management (2013, Department of Mechanical and Manufacturing Engineering, School of Engineering, University of Nairobi)	Margaret Kanini's thesis focusses on domestic consumption in Nairobi region. This is a detailed and well documented study permitting extrapolation and forecast. Its approach, data and assumptions are closely related to the household survey conducted under the LCPDP (see previous record)
Ecocare International, Final Report on the Development of Energy Performance Baselines and Benchmarks and the Designation of Industrial, Commercial and Institutional Energy Users in Kenya (February 2013- Energy Regulatory Commission)	Report wanted to give a view towards benchmarking for industries and large commercial and institutional buildings. However this ambition could not be achieved because of the poor or uncertain quality of the available data.
Small scale CDM programme activity (cpa) 0001 - Green light for Africa - Programme of activities (2012 KPLC, Kenya)	The report describes the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to household lighting activities.
The Standards and Labelling Programme in Kenya - Mid-Term Evaluation (2012,supported by GEF implemented by UNDP for the Government of Kenya)	This mid-term evaluation report provides information on completion of activities related to the selection and adoption of International Test Procedures (ITP), Minimum Energy Performance Standards (MEPS) and Label classification.
Audits of industrial facilities (2005-2013, supported by Kenya Association of Manufacturers -KAM)	A collection of 30 energy audits provides an overview and data on energy end-use and potentials of savings. The sample is small compared to all audits performed and data quality is uneven.
Audits of large buildings grouping commercial institutional facilities.	A collection of 11 energy audits provides an overview and data on energy end-use and potentials of savings

4 POTENTIAL OF EE IN THE RESIDENTIAL SUBSECTOR

4.1 Key results and conclusions

The key results, corresponding conclusions and planning recommendations are presented below.

- The following table summarises the expected savings in the residential subsector for five-year periods for each region of Kenya.

Table 4-1:Expected savings in the residential subsector

Region	Unit	2020	2025	2030	2035	Total
Nairobi	GWh	80	241	315	414	1,050
Coastal	GWh	14	42	55	73	183
Mt Kenya	GWh	19	61	83	118	280
Western	GWh	24	87	133	190	434
Total	GWh	136	430	586	795	1,948
Aggregated saving percentage	%	7%	23%	30%	39%	100%

- Not surprisingly, the Nairobi region is the main source of savings.
- Greatest savings are to be expected from new customers rather than from the existing customers. Actions should thus especially target new customers, at the time of their connection either as newly electrified customers or socially-migrating customers.
- High- and middle-income urban social groups are preferred targets for EE efficiency measures as they are users of energy-intensive appliances such as air conditioner (A/C) and water heating.
- All groups are concerned by efficient lighting which remains a priority action even if significant progress has been made in awareness among the general public.

4.2 Methodology for categorising residential consumers

If not mentioned otherwise all data in this sub section are extracted from LCPDP Egis reports, data from household and related documents[13]. Most data refer to Nairobi only. Therefore, assumptions for the other regions had to be transferred to the other regions using a rather global approach. Given the dominance of Nairobi in the present and future electricity demand the uncertainties with regard to this approach are considered acceptable for the purpose of this study.

[13] See Table 3-4 for details on sources.

Kenya connected residential and small commercial consumers are split between six socio-geographical groups according to their power consumption and their location in urban/rural area in three different regions: Nairobi region, Coastal region, and rest of Kenya.

The distribution pattern is summarised in the following table:

Table 4-2: Definition of socio-geographical groups

Urban sample		Rural sample	
Consumption range (kWh/year)	Category	Consumption range (kWh/year)	Category
More than 3000	High income (Hi)	More than 1000	High income (Hi)
Between 1000 and 3000	Middle income (Mi)	Between 500 and 1000	Middle income (Mi)
Less than 1000	Low income (Li)	Less than 500	Low income (Li)

The distribution of the customers across the socio-geographical groups for three main regions in Kenya was calculated using the KPLC database:

Table 4-3: Distribution of customers according to socio-geographical groups

	Urban sample			Rural sample		
Region	Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li
Nairobi	14.4%	28.9%	46.9%	1.0%	3.4%	5.4%
Coastal	7.9%	15.7%	25.6%	0.8%	7.5%	42.5%
Rest of Kenya	3.9%	7.8%	12.7%	1.0%	11.0%	63.5%

Source: KPLC 2013

The table below defines the main electricity appliances used by residential customers:

Table 4-4: Main category definitions for domestic appliances

	End use category	Appliances
1	Air conditioning	Air conditioning system, fan
2	Laundry	Washing machine, iron box
3	Cooking	Electric cooker, microwave oven, deep fryer, rice cooker, extractor hood, built-in oven
4	Dish washing	Dish washer
5	Entertainment and ICT	Television set, Home theatre system, stereo, DVD player, VCD player, VCR player, video console game, satellite decoder, computer, computer monitor, laptop, computer scanner, computer printer, house telephone, mobile charger
6	Fitness	Swimming pool, gym equipment, sauna/Jacuzzi, steam bath
7	Grooming	Electric shaver, hair dryer

	End use category	Appliances
8	House cleaning	Vacuum cleaner
9	Space heating	Fan heaters
10	Lighting	Lighting, rechargeable torch
11	Refrigeration	Refrigerator, Freezer
12	Sanitary water	Geyser heater, instant shower heater, immersion heater
13	Small kitchen appliances	Coffee maker, bread toaster, blender/juicer, electric kettle, water dispenser
14	Water supply	Water booster pump

The average consumption and rate of access per main power use according to the six socio-economic groups for Nairobi region are as follows[14]:

Table 4-5: Electricity consumption per end use category

	Consumption per use (kWh)					
End use	Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li
A/C system	6845	4925	3623	5493	4141	4663
Laundry	466	335	246	374	282	317
Cooking	311	412	297	359	270	304
entertainment/ICT	1555	1119	823	1248	941	1059
dishwashing	581	771	308	466	352	396
Fitness	933	671	494	749	565	636
grooming	36	26	19	29	22	24
house cleaning	119	86	63	96	72	81
space heating	107	77	57	86	65	68
Lighting	1219	350	105	978	294	135
refrigeration	2607	1875	1380	2092	1577	1776
sanitary water	2355	1695	1247	1890	1425	1605
small kitchen appliances	981	706	519	788	594	668
water supply	121	87	64	97	73	82

[14] Data are extracted from a statistical analysis. Please note that the quality of the calculated figures depends on the extent and representativeness of the underlying data. Some data might be erratic. This could be the case for the MI group utilization of dishwashers while for HI group this data is probably more representative and mitigated. Similar explanation can apply to refrigeration, grooming, cooking, fitness, cleaning and electrical space heating given the low level of access. For laundry and ICT, it is not abnormal that rural customers have a slightly more intensive use of these appliances (ironing, TV) with a lower level of access. In addition, please note that it is possible that the field inquiries identified uncommon users that made possible to mention a specific consumption (provided in Table 4-5) although the rate of access is negligible (provided in Table 4-6). This case does not influence saving estimates.

Table 4-6: Access rate to end-use category in Nairobi region

End use	Rate of access in Nairobi region Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li
A/C system	11 %	7 %	-	3 %	-	-
Laundry	74 %	49 %	42 %	31 %	35 %	9 %
Cooking	39 %	10 %	-	5 %	3 %	-
entertainment/ICT	48 %	30 %	21 %	21 %	22 %	10 %
dishwashing	12 %	-	-	-	-	-
Fitness	6 %	0 1%	-	-	-	-
grooming	33 %	8 %	3 %	3 %	-	-
house cleaning	36 %	3 %	-	-	-	-
space heating	15 %	2 %	-	-	-	-
Lighting	100 %	100 %	100 %	100 %	100 %	100 %
refrigeration	26 %	12 %	2 %	6 %	5 %	-
sanitary water	42 %	20 %	5 %	5 %	4 %	-
small kitchen appliances	58 %	18 %	3 %	7 %	3 %	-
water supply	48 %	7 %	-	6 %	-	-

The access table can be extrapolated to the Coastal region to take into account a larger expansion of the use of A/C systems and fans.

Table 4-7: Access rate to end-use category in coastal region

End use	Rate of access in Coastal Region Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li
A/C system	30 %	10 %	-	8 %	-	-
Laundry	74 %	49 %	42 %	31 %	35 %	9 %
Cooking	39 %	10 %	-	5 %	3 %	-
entertainment/ICT	48 %	30 %	21 %	21 %	22 %	10 %
dishwashing	12 %	-	-	-	-	-
Fitness	6 %	-	-	-	-	-
grooming	33 %	8 %	3 %	3 %	-	-
house cleaning	36 %	3 %	-	-	-	-
space heating	15 %	2 %	-	-	-	-
Lighting	100 %	100 %	100 %	100 %	100 %	100 %
refrigeration	26 %	12 %	2 %	6 %	5 %	-
sanitary water	42 %	20 %	5 %	5 %	4 %	-
small kitchen appliances	58 %	18 %	3 %	7 %	3 %	-
water supply	48 %	7 %	-	6 %	-	-

The average consumption per appliance in the whole Kenya is supposed to remain the same as in Nairobi region. The rate of access in the rest of Kenya is supposed to be similar to Nairobi's.

Based on the socio-geographic breakdown, the average consumptions per appliance and the average rate of access per region, it is possible to calculate the EE potential savings once the savings per appliance are estimated.

4.3 Potential savings of EE - residential customers

The following table, established according to the Consultant's expertise, indicates the savings per appliance that can be expected in the following years and the main rationale for those savings.

Table 4-8: Energy savings rate for existing residential customers[15]

	Savings rate						Rationale for savings		
	Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li	Technology	Regulation	Action
A/C system	30 %	10 %	-	10 %	-	-	Compressor		Labelling
Entertainment / ICT	10 %	10 %	10 %	10 %	10 %	10 %	ICT		
Lighting	60 %	60 %	60 %	60 %	60 %	60 %	LED		Labelling
Refrigeration	50 %	50 %	50 %	50 %	50 %	50 %	Compressor		Labelling
Sanitary water	100%	50 %	50 %	50 %	50 %	-		solar water heaters, geysers	

Based on the classification in the previous sub section, it is now possible to evaluate the average savings potential per consumer depending on the location and socio-economic group:

Table 4-9: Average saving potential per customer and usage in Kenya[16]

	Average saving potential per customer (kWh)					
End use	Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li
A/C system	263	36	0	19	0	0
entertainment/ICT	75	34	17	26	21	11
lighting	731	210	63	587	176	81
refrigeration	339	113	14	63	39	0
sanitary water	989	170	31	47	29	0

[15] Source: consultant calculation

[16] Source: consultant household survey among more than 700 connected and not connected households (urban and rural) in Western Kenya (May – October 2016

Table 4-10: Average saving potentials per region[17]

	Average saving potential per customer (kWh)					
Region	Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li
Nairobi	2,360	560	125	739	265	92
Coastal	2,750	575	125	767	265	92
Rest of Kenya	2,360	560	125	739	265	92
Kenya	2,397	561	125	742	265	92

Based on KPLC customer data, which provides the number of residential customers per region, potential savings in GWh can be calculated.

Table 4-11: Customers per region (reference year 2013)[18]

Region	Nairobi	Coastal	Rest of Kenya
Number of customers	980,273	221,320	817,197

The total savings potential for Kenya for existing residential customers amounts to about 870 GWh. This is about 40% of the recent annual domestic consumption.

Table 4-12: Total saving potential per region (reference financial year 2012/2013)[19]

	Total savings (GWh)						
Region	Urban Hi	Urban Mi	Urban Li	Rural Hi	Rural Mi	Rural Li	total
Nairobi	334 .0	158 .5	57 .6	14 .2	6 .3	4 .8	575 .4
Coastal	47 .9	20 .0	7 .1	1 .4	4 .4	8 .6	89 .4
rest of Kenya	78 .1	37 .1	13 .5	6 .1	23 .6	47 .0	205 .3
Total	**460 .0**	**215 .6**	**78 .2**	**21 .7**	**34 .3**	**60 .4**	**870 .2**

Based on the Consultant's experience it is conservatively estimated that 50% of this potential can be captured within a ten-year period, taking effect from 2019 onwards. This capture will be realized at a rate of 5% per annum.

Similarly, 50% of the remaining potential savings will be captured by the average customer of each socio-geographical group during the next decade, starting from 2029.

[17] These saving potentials will be adjusted in proportion of the actual specific consumptions predicted in the demand scenarios.
[18] Source: KPLC data and consultant calculation
[19] Source: consultant calculation - Based on 4,000 h duration of peak use with electricity demand of 218 MW

4.4 Potential savings of EE - new residential consumers

New residential consumers consist of the following connected customers categories:

- Customers who have never been connected and can be linked to any already defined existing socio-geographical group.
- Customers who had previously been attached to another socio-geographical group and achieved a socio-economic or/and geographical migration

The following rules will apply to the consumption of the new residential consumers:

- The average consumption of the new customers will adjust on the average consumptions of their socio-geographical group taking into account the average savings already realized by this group by the time of their connection.
- The average consumption of the new consumers will subsequently follow the average consumption of their socio-geographical group.

4.5 Results

The annual savings realized by the residential sector must be evaluated based on the assumption that the average customer in each socio-geographic group maintains 2013 consumption levels. Savings depend on several factors:

- The rules for calculation described in paragraphs 4.3 and 0 above.
- The residential consumption growth rate underlying the demand scenario in question before including savings.
- Variations in the customer distribution across the socio-geographical groups due to demographics, electrification, and geographical and social migration. Assumptions must be made for some of these parameters for residential EE purposes, in particular for social migration. It is thus assumed that each year 1% of the two lower social groups will join the next highest group in each geographical group in the reference scenario; 1.5% in the vision scenario; and 0.5% in the low-growth scenario. The rest of growth will come from new customers due to demographics and electrification and will be aligned with the current social distribution in each geographical region.

The following results are obtained with the above procedure for the reference demand scenario for each region of Kenya.

Table 4-13: Results obtained for the reference demand scenario for each region of Kenya

Nairobi GWh	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	total
High income urban	0	0	0	23	25	26	27	29	31	32	34	36	38	40	42	45	47	50	53	56	634
Medium income urban	0	0	0	11	11	12	12	13	14	14	15	16	17	18	19	20	21	22	23	25	282
Low income urban	0	0	0	4	4	4	4	4	5	5	5	5	6	6	6	7	7	7	8	8	95
High income rural	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Medium income rural	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Low income rural	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	8
Aggregate	0	0	0	39	41	43	46	48	51	53	56	59	63	66	70	74	78	83	87	92	1,050

Coast GWh	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	total
High income urban	0	0	0	4	4	4	4	5	5	5	5	6	6	6	7	7	7	8	8	9	100
Medium income urban	0	0	0	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	40
Low income urban	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
High income rural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Medium income rural	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
Low income rural	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Aggregate	0	0	0	7	14	21	29	38	46	56	65	76	87	98	110	123	137	151	167	183	183

Mt Kenya GWh	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	total
High income urban	0	0	0	3	4	4	4	5	5	5	5	6	6	7	7	8	8	9	9	10	105
Medium income urban	0	0	0	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	5	49
Low income urban	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	17
High income rural	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
Medium income rural	0	0	0	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	34
Low income rural	0	0	0	2	2	2	3	3	3	3	3	4	4	4	4	5	5	5	6	6	64
Aggregate	0	0	0	9	19	29	41	53	66	79	94	110	126	144	163	183	205	228	253	280	280

Western GWh	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	total
High income urban	0	0	0	4	5	5	6	7	7	8	8	9	10	11	11	12	13	14	15	17	163
Medium income urban	0	0	0	2	2	2	3	3	3	4	4	4	5	5	5	6	6	7	7	8	76
Low income urban	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	27
High income rural	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	15
Medium income rural	0	0	0	1	2	2	2	2	2	3	3	3	3	3	4	4	4	5	5	5	53
Low income rural	0	0	0	3	3	3	4	4	4	5	5	6	6	7	7	8	8	9	9	10	100
Aggregate	0	0	0	12	24	38	54	72	91	111	134	158	185	213	244	277	312	350	391	434	434

Kenya GWh	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	total
High income urban	0	0	0	34	37	39	42	45	47	50	53	57	60	64	68	72	76	81	86	91	1,003
Medium income urban	0	0	0	16	17	18	19	20	21	22	24	25	27	28	30	32	34	36	38	41	446
Low income urban	0	0	0	5	6	6	6	7	7	8	8	9	9	10	10	11	12	12	13	14	154
High income rural	0	0	0	1	1	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	43
Medium income rural	0	0	0	3	4	4	4	5	5	6	6	6	7	7	8	8	9	9	10	11	113
Low income rural	0	0	0	6	6	7	7	8	9	9	10	11	11	12	13	14	15	16	17	18	189
Aggregate	0	0	0	66	136	212	292	378	470	567	670	780	897	1,021	1,153	1,292	1,441	1,599	1,768	1,948	1,948

5 POTENTIAL OF EE IN THE INDUSTRY SECTOR

5.1 Key results and conclusions

The key results, corresponding conclusions and planning recommendations are presented below.

- The following table summarises the expected savings in the industrial subsector in Kenya.

Table 5-1:Annual electricity consumption per industrial subsectors in Kenya

Kenya total	Unit	2020	2025	2030	2035	Total
Total savings per five-year period	GWh	297	630	773	1,067	2,766
Aggregated	GWh	297	927	1,699	2,766	2,766
Aggregated savings	%	11%	23%	28%	39%	100%

- Lack of information and the variable quality of audits seriously hampered the evaluation of the actual saving potential in the industrial subsector.

- However the subsector is expected to experience strong development and deep transformations encouraged by the energy boom in the future. Consequently, greater savings can be expected from new customers than from existing ones and actions should especially focus on the former at the time of their connection. International best practice standards should be systematically used when checking customer equipment.

- KAM should provide the energy subsector with updated information on audit results, both at existing and new industrial premises. This will facilitate sharing of good practices and information management and monitoring.

5.2 Power analysis of the industry sector in Kenya

KPLC provided a data base displaying the annual electricity consumption for each of the 42 industrial subsectors that are present in Kenya. The data is based on a sample of more than 700 large industrial and commercial consumers which represent more than 50% of total industrial and commercial consumption. The following table shows the data for the four financial years 2009 / 2020 to 2012 / 2013 and up to April 2014. The financial year 2012/2013 is the latest available complete data set and therefore used as basis for most calculations. The industrial subsectors are ranked according to their electricity consumptions. This ranking is stable over the recent years, at least, for the largest consuming subsectors.

Table 5-2: **Annual electricity consumption per industrial subsectors in Kenya**

	Electricity consumption (MWh) for financial year				
Subsectors	**2013 /2014**	**2012 /2013**	**2011 /2012**	**2010 /2011**	**2009 /2010**
Cement, lime & plaster plants	285 ,198	285 ,184	234 ,534	284 ,307	211 ,367
Other supplies in the industry	149 ,448	154 ,747	129 ,666	96 ,405	67 ,891
Plastic manufacturers	101 ,786	113 ,475	97 ,109	96 ,992	79 ,088
Metal products	101 ,175	117 ,307	105 ,302	103 ,432	78 ,709
Tea estate	97 ,069	110 ,243	91 ,514	104 ,564	108 ,284
Basic metal industry	85 ,569	102 ,315	87 ,644	96 ,345	85 ,357
Other petroleum supplies	85 ,004	96 ,276	77 ,433	85 ,851	87 ,168
Grain mills	78 ,755	92 ,025	81 ,449	80 ,435	69 ,370
Industrial chemical plants	66 ,777	86 ,331	69 ,616	30 ,094	16 ,215
Salt mine	58 ,670	70 ,027	68 ,148	78 ,902	70 ,735
Other chemical products plants	41 ,136	46 ,251	36 ,966	35 ,306	33 ,488
Water transport operators	37 ,570	41 ,941	31 ,638	33 ,793	26 ,361
Soft drink manufacturers	37 ,424	33 ,652	22 ,753	24 ,687	22 ,544
Sugar factories & refineries	36 ,238	39 ,507	39 ,935	37 ,681	38 ,612
Petro station	32 ,463	35 ,702	28 ,636	27 ,443	27 ,495
Horticulture	31 ,140	32 ,282	28 ,560	30 ,712	24 ,779
Public water supplies	29 ,150	30 ,012	28 ,496	22 ,889	20 ,843
Metal mining	27 ,394	5 ,064	4 ,721	4 ,599	2 ,164
Glass & glass products	26 ,758	32 ,188	27 ,338	30 ,765	32 ,724
Pulp, paper & paper products	26 ,678	26 ,916	35 ,454	37 ,911	28 ,728
Civil aviation & air operators	25 ,923	25 ,072	21 ,264	19 ,393	15 ,995
Sawmills	23 ,739	27 ,928	31 ,088	25 ,558	16 ,240
Dairy	20 ,787	20 ,990	21 ,249	21 ,744	20 ,347
Petroleum product refineries	19 ,927	40 ,290	39 ,516	55 ,526	56 ,519
Wood & cork product(furniture)	18 ,523	22 ,794	20 ,937	19 ,567	17 ,347
Rubber products	18 ,176	20 ,722	16 ,672	18 ,035	17 ,343
Tobacco product manufacturers	17 ,807	18 ,561	20 ,569	25 ,564	22 ,268
Clothing manufacturers	14 ,356	15 ,153	9 ,097	10 ,258	10 ,098
Kenya ports authority	13 ,430	12 ,354	7 ,874	16 ,401	17 ,550
Knitting mills	11 ,005	11 ,964	10 ,723	10 ,439	8 ,462
Footwear except plastic & rubber	10 ,500	13 ,164	13 ,552	13 ,138	12 ,034
Gas manufacturers	8 ,482	10 ,051	10 ,664	11 ,929	10 ,274
Soap manufacturers	8 ,262	8 ,810	8 ,099	7 ,986	7 ,711
Grain storage	7 ,124	8 ,682	8 ,697	7 ,036	8 ,258
Breweries & malt salt handlers	5 ,044	8 ,391	7 ,730	10 ,777	9 ,895
Cotton ginneries	4 ,184	4 ,782	4 ,831	4 ,951	4 ,752
Animal feeds manufacturing	3 ,773	3 ,970	4 ,241	4 ,268	3 ,604
Synthetic resin manufacture	3 ,128	3 ,125	3 ,137	3 ,830	3 ,622
Directorate of civil aviation	2 ,440	2 ,837	3 ,375	3 ,536	2 ,967
Wine manufacturers	1 ,136	1 ,031	1 ,141	1 ,062	800
Tobacco growing	345	700	456	423	658
Wood carvers	121	144	166	241	247
Total	**1 ,673 ,613**	**1 ,832 ,961**	**1 ,591 ,993**	**1 ,634 ,776**	**1 ,398 ,914**

According to the financial year 2012/2013 results, the first ten subsectors account for two thirds of the industrial consumption. The following ten subsectors account for 18% and the rest (22 subsectors) for only 15%.

5.3 Energy audits in industrial entities

As mentioned earlier in the section, KAM/CEEC recently realized a great number of audits in the industrial sectors (nearly 450, combining the commercial and institutional sector). Unfortunately only some 30 audits were available for review.

In addition, the quality of the audits is not homogeneous. Many do not mention the energy savings but only the value of the savings in KES, which result in making hazardous conversions necessary due to the volatile and complex structure of the tariffs. Volume of products is often missing, which is an obstacle to any benchmarking effort.

Notwithstanding this remarks, the following analysis was carried out to at least demonstrate what can be done at a higher reliability and quality level, provided that more data is available.

The following table details, per subsector, the potential savings that were detected in the audited companies. The data per company is not shown for confidentiality reasons. The size of the sample per subsector is very small and not representative by any account.

Table 5-3: Sample characteristics of audited industrial companies

Subsector	Number of companies	Subsector	Number of companies
Horticulture	1	Pharmaceutical	3
Plastic	3	Steel and structures	1
Tea	5	Dairy	2
Water and sanitation	5	Leather	1
Food and beverage	1	Paper and pulp	2
Food processing	4	Unclassified	2

It has to be noted that the steel and structure representative audit did not show any power savings and only 27 audits could be used for the following Table 5-4.

Nevertheless, the table shows that the largest savings can be expected from improving the compression systems, the motors performance and lighting. Dairy and food sectors show the most savings potential.

Table 5-4: EE activities and potential savings within audited industrial subsectors[20]

	Potential Savings (MWh) - audited subsectors										
EE activities	**Dairy**	**Food and beverage**	**Unclassi-fied**	**Paper and pulp**	**horticul-ture**	**Food pro-cessing**	**Tea**	**Water & sanitation**	**Leather**	**Plastic**	**Pharma.**
Compressed air	14.3	23.1	485.1	130.9	4.8	91.7	-	-	691.9	250.5	14
Speed drives	5.5	-	62	156.2	11	10.9	699.7	-	-	918.2	-
Lights	9.1	200.6	19.7	86	6.1	163.9	82.7	128.2	207.8	204.3	4.5
Control	24.5	-	89.2	4.7	-	98.8	161.2	76.7	-	6	-
Motors	25.98	-	100.6	190.7	-	74.7	-	590.9	-	68.1	10.5
Ballast	-	-	19.5	16.9	-	39.2	-	2.8	-	7.4	3.2
Water pumping	-	21.1	-	-	198	25.9	-	458.5	30	-	-
ICT	-	-	-	-	-	-	-	-	-	-	-
Water heater	3	-	-	-	-	35	-	-	-	-	-
Insulation	1.6	-	-	-	-	3.9	41.9	-	-	-	-
Power factor	-	-	-	-	-	-	-	-	-	-	-
Cooling systems	-	339.3	-	-	-	4.8	-	-	-	43	18.7
Oven	-	-	-	-	-	-	-	-	-	44.9	-
Dryer	-	-	-	-	-	157.7	-	-	-	-	-
Gasifier	-	-	-	-	-	1,440	-	-	-	-	-
Total savings	84	584.1	776.1	585.4	219.9	2,146.5	985.5	1,257.1	929.7	1,542.4	50.9
Percentage savings	34.7%	21.7%	18.5%	9.0%	13.9%	12.0%	8.5%	8.2%	7.3%	7.2%	2.7%

[20] Source: consultant calculations

A survey among industrial and commercial entities was started to complement the patchy data from energy audits. Preliminary results[21] among the very large industrial and commercial consumers in the country show a positive picture: 93% of the interviewed entities were audited for energy of which 89% carried out energy saving measures, half of them with energy savings as expected or even higher. However, half of measures were implemented in the less challenging field of lighting.

5.4 Methodology for categorization of industrial consumers

For the further evaluation of the potential, it is necessary to extrapolate the savings detected in the sample to the whole industry sector. As the sample only covers 10 sectors, while KPLC database is considers 42, many grouping assumptions were made based on similar uses of electricity in industrial processes.

The lack of information in some sub-sectors has justified this approach. However, it would no longer be appropriate if and when the number and representativeness of the sampled energy audits improves.

Table 5-5: Relatedness between energy audit groups and KPLC industrial sub-sectors and corresponding saving ratio[22]

Reference audit group	Related KPLC subsectors	Saving ratio
Plastic	Plastic manufacturers Glass & glass products Rubber products Synthetic resin manufacture	7.2%
Food processing	Grain storage Animal feeds manufacturing Wine manufacturers	12%
Tea	Tea estate Cotton ginneries	8.5%
Pharmaceutical	Industrial chemical plants Other chemical products plants	2.7%
Water and sanitation	Water transport operators Other supplies in the industry Public water supplies Civil aviation & air operators Kenya ports authority	8.2%

[21] At the time of the study the first batch of interviews among 30 very large consumers was available. This number can only provide indicative results though the sample represents the geographical and sector distribution of large entities.
[22] Source: consultant estimations

Reference audit group	Related KPLC subsectors	Saving ratio
	Directorate of civil aviation	
	Petro station	
Food and beverage	Soft drink manufacturers	21.7%
	Breweries & malt salt handlers	
Horticulture	Horticulture	13.9%
	Tobacco growing	
Paper and pulp	Pulp, paper & paper products	9%
	Other petroleum supplies	
	Sugar factories & refineries	
	Petroleum product refineries	
Dairy	Dairy	34.7%
	Soap manufacturers	
Leather	Clothing manufacturers	7.3%
	Footwear except plastic & rubber	
	Knitting mills	
	Wood & cork product(furniture)	
	Wood carvers	
Cement, lime & plaster plants	Cement, lime & plaster plants	
	Grain mills,	
	Salt mine,	
	Metal mining	
	Sawmills	
Basic metal industry	Basic metal industry	
	Metals products	

Two highly energy intensive KPLC subsectors could not be classified as they do not have a reasonable representation among the audited subsectors: Cement, Lime & Plaster Plants and Basic Metal Industry. These subsectors rank in the first six consuming subsectors with Cement, Line & Plaster Plants ranking first. Since most of the electricity used for the Cement, Lime & Plaster Plants is for grinding, Grain Mills, Salt Mine, Metal Mining, and Sawmills subsectors are related. Metal Products subsector has been assimilated to Basic Metal Industry.

Potential savings in both subsectors were deduced from the reference Global Industrial Energy Efficiency Benchmarking (November 2010 - UNIDO). Relevant sheets for cement and metal are copied in Annex 5.A. For cement, the paper indicates that the average saving potential is 16%. For iron and steel, Africa efficiency index (1.8) could be brought down to the level of Asia Developing countries (1.50), which would represent a saving potential of 16%.

5.5 Potential savings of EE – industrial sector

The saving potential of the existing industrial consumers can be roughly evaluated applying the saving rate to the consumption of each KPLC subsector. The following results are obtained:

Table 5-6: EE saving potential in industrial sub-sectors

	Savings (MWh)				
Subsectors	**2013 /2014**	**2012 /2013**	**2011 /2012**	**2010 /2011**	**2009 /2010**
Cement line & plaster plants	45,631	45,629	37,525	45,489	33,818
Other supplies in the industry	12,255	12,690	10,633	7,905	5,567
Plastic manufacturers	7,329	8,171	6,992	6,984	5,695
Metal products	16,188	18,769	16,848	16,549	12,593
Tea estate	8,251	9,371	7,779	8,888	9,204
Basic metal industry	13,691	16,370	14,023	15,415	13,657
Other petroleum supplies	7,650	8,664	6,969	7,726	7,845
Grain mills	12,601	14,724	13,032	12,870	11,099
Industrial chemical plants	1,803	2,331	1,880	813	438
Salt mine	9,387	11,204	10,904	12,624	11,318
Other chemical products plants	1,111	1,249	998	954	904
Water transport operators	3,081	3,439	2,595	2,771	2,162
Soft drink manufacturers	8,121	7,302	4,937	5,357	4,892
Sugar factories & refineries	3,261	3,555	3,594	3,391	3,475
Petro station	2,662	2,928	2,348	2,250	2,255
Horticulture	4,328	4,487	3,969	4,269	3,444
Public water supplies	2,390	2,461	2,336	1,877	1,709
Metal mining	4,383	810	755	736	346
Glass & glass products	1,927	2,318	1,969	2,216	2,357
Pulp paper & paper products	2,401	2,422	3,191	3,412	2,585
Civil aviation & air operators	2,126	2,056	1,744	1,590	1,312
Sawmills	3,798	4,468	4,974	4,089	2,598
Dairy	7,213	7,283	7,373	7,545	7,060
Petroleum product refineries	1,793	3,625	3,556	4,996	5,085
Wood & cork product(furniture)	1,352	1,664	1,528	1,428	1,266
Rubber products	1,309	1,492	1,201	1,299	1,249
Tobacco product manufacturers	1,514	1,578	1,749	2,174	1,893
Clothing manufacturers	1,048	1,106	664	749	737
Kenya ports authority	1,101	1,013	646	1,345	1,439
Knitting mills	803	873	782	762	617
Footwear except plastic & rubber	767	962	990	960	879
Gas manufacturers	696	825	875	979	843
Soap manufacturers	2,867	3,057	2,810	2,771	2,676
Grain storage	855	1,042	1,044	844	991

	Savings (MWh)				
Subsectors	**2013 /2014**	**2012 /2013**	**2011 /2012**	**2010 /2011**	**2009 /2010**
Breweries & malt salt handlers	1,095	1,822	1,678	2,340	2,148
Cotton ginneries	356	407	411	421	404
Animal feeds manufacturing	453	477	509	512	433
Synthetic resin manufacture	225	225	226	275	261
Directorate of civil aviation	200	233	277	290	243
Wine manufacturers	136	123	137	127	96
Tobacco growing	48	97	63	59	92
Wood carvers	9	11	12	18	18
Total Savings	198,216	213,334	186,526	198,068	167,705
Electricity consumption	1,673,614	1,832,960	1,591,990	1,634,775	1,398,913
Saving ratio	11.8%	11.6%	11.7%	12.1%	12.0%

For all the considered financial years, the rate of potential savings is stable at 12.0 % totalizing about 229 GWh in financial year 2012/2013, i.e. 35.5 MW at peak with 6,000h duration of peak use. This low figure confirms the low level of potential savings in industry, as already shown in the overall KAM/CEEC audits.

It is assumed that existing customers will capture potential savings by following the EE regulation now enforced for the designated large customers. This will result in 6% savings for the first three-year period starting in 2019, 3% for the second, 1.5% for the third and 0.75% for the fourth. By 2029 they will have captured nearly 10% savings. Nevertheless, they will remain far from the Best Practice Technology (BPT) as defined by UNIDO in the report *Global Industrial Energy Efficiency Benchmarking: An Energy Policy Tool*.[23] This report states that savings of 1.2% per annum are necessary to enable industries of developing countries to adhere to the BPT. Consequently, additional audits based on BPT comparison need to identify 14% additional savings to be captured after 2029 that could be achieved at a rate of 1.4% per annum in the 2029-2035 period.

It should be emphasised at this point that in the years to come, the Kenyan industrial sector will completely change, and the existing industrial premises will become progressively marginal in the sector. Forecasting these developments is challenging. This is why reference to the global UNIDO approach appears relevant, all the more so as the saving figures found in the audits of the existing industries are close to UNIDO figures (12% to capture in twelve years for the former, and 1.2% per annum for the latter).

[23] Assuming that overall energy figures are still valid for power only

5.6 Potential savings of EE - new industrial consumers

New industrial consumers consist of those that are newly connected after 2014 or those that have substantially increased their demand after that date.

In line with the audit regulations, these customers will be have to undergo a detailed efficiency review of their project. They will be obliged by law to respect the Best Practice Technology as defined by UNIDO. Consequently these customers will virtually achieve 24% immediate savings with respect to their assumed consumption with 2015 technology and practice in Kenya. The volume of savings in absolute terms will depend on the growth scenario, assuming that the extra consumption per annum reflects the impact of the “new consumers” as defined above, the rest of the industrial consumption being attributed to the premises of “old consumers”.

5.7 Results

The following table shows the predictable savings that would result from the above assumptions:

Table 5-7: Expected savings from industry sector

Kenya	Unit	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Savings rate on existing		-	-	-	2%	2%	2%	1%	1%	1%	0,5%
Savings rate on new		-	-	-	24%	24%	24%	24%	24%	24%	24%
Total savings	GWh	0	0	0	147	150	154	116	121	127	111
Aggregated	GWh	0	0	0	147	297	451	567	689	815	927
% aggregated savings		0%	0%	0%	5%	5%	6%	4%	4%	5%	4%

Kenya	Unit	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Savings rate on existing		0,5%	0,5%	1,4%	1,4%	1,4%	1,4%	1,4%	1,4%	1,4%	1,4%
Savings rate on new		24%	24%	24%	24%	24%	24%	24%	24%	24%	24%
Total savings	GWh	117	124	169	177	185	194	203	213	223	234
Aggregated	GWh	1,044	1,168	1,337	1,514	1,699	1,893	2,095	2,308	2,531	2,766
% aggregated savings		4%	4%	6%	6%	7%	7%	7%	8%	8%	8%

6 POTENTIAL OF EE IN THE COMMERCIAL/INSTITUTIONAL SECTOR

6.1 Key results and conclusions

The key results, corresponding conclusions and planning recommendations are presented below.

- The following table summarises the expected savings in the commercial and institutional sector in Kenya

Table 6-1:Expected savings in the commercial and institutional sector

Kenya	Unit	2020	2025	2030	2035	Total
Total savings per five- year period	GWh	409	741	509	539	2,198
Aggregated	GWh	409	1,151	1,659	2,198	2,198
% aggregated savings		19%	34%	23%	25%	100%

- Lack of information and the variable quality of audits seriously hampered the evaluation of the actual saving potential in the existing commercial and institutional sector.

- However the subsector is experiencing strong development, especially in Nairobi. Consequently, greater savings can be expected from new customers than from existing ones, and actions should especially focus on the former at the time of building design and connection.

- Zero consumption and positive energy building technologies should be employed for large buildings.

- KAM should provide the energy subsector with updated information on audit results, both at existing and new premises. This will facilitate sharing of good practices and information management and monitoring.

6.2 Power analysis of the commercial and institutional sector in Kenya

KPLC provided a data base displaying the annual electricity consumption for each of the six commercial subsectors that are present in Kenya. The data is based on a sample of more than 700 large industrial and commercial consumers which represent more than 50% of total industrial and commercial consumption. The following table shows the data for the last four financial years 2009 / 2020 to 2012 / 2013 and up to April 2014. The financial year 2012/2013 is the latest available complete data set and therefore used as basis for most calculations. The subsectors are ranked according to their electricity consumptions. This ranking is stable over the recent years, at least, for the largest consuming subsectors.

Table 6-2: Electricity consumption of commercial and institutional KPLC customers

KPLC subsector	Electricity Consumption (MWh) 2013 / 2014	2012 / 2013	2011 / 2012	2010 / 2011	2009 / 2010
Office blocks	53,012	62,085	59,362	59,297	50,404
Hotels, lodging &boarding houses	50,488	56,882	51,900	55,835	43,391
Combined w/sale & retail trade	50,296	62,181	58,563	60,072	51,450
Hospitals	36,173	39,242	34,863	33,145	28,927
Universities	22,831	24,781	21,947	23,253	18,661
Offices & office suites	11,061	9,284	9,513	6,151	3,105
Total	**223,860**	**254,455**	**236,148**	**237,753**	**195,938**

6.3 Energy audits in commercial and institutional sector

This sub section applies to consumers whose premises are located in large buildings. Most remarks mentioned for industrial sector energy audits also apply here. Not enough audits are available to ensure the representativeness of the sample.

However, the number of KPLC subsectors is reduced and there is at least one audited representative for each KPLC category except for the hotels, lodgings and boarding houses that are supposedly related to offices and office suites categories. Once again there is no metric data associated with each building (total floor surface for instance). This makes a true benchmarking impossible.

The following table details, per subsector, the potential savings that were detected in the audited buildings. The data per building is not shown for confidentiality reasons. The size of the sample per subsector is very small and not representative by any account.

Table 6-3: Sample characteristics of audited commercial and institutional entities

Subsector	Number of audited entities
Government buildings	2
Shopping centres	2
Health and hospitals	3
Private buildings	2
Universities	2

Unsurprisingly, lighting and water heating accumulate most of the saving potential. Government and private buildings and hospitals are the top potential saving subsectors.

Table 6-4: Detailed EE savings analysis from energy audits sample in commercial and institutional subsector[24]

	EE Saving potentials (MWh)				
EE activities (MWh)	Government buildings	Shopping centres	Health and hospitals	Private buildings	Universities
Compressed air	-	-	5	-	-
Speed drives	-	-	175	-	-
Lights	1,177	35	5,502	167	23
Control	4	19	70	-	-
Motors	35	-	-	-	-
Ballast	-	-	42	58	10
Water pumping	-	-	-	-	-
ICT	-	1	-	-	-
Water heater	-	2	2.37	-	78
Power factor	-	-	-	-	-
Cooling systems	149	12	-	-	-
Oven	-	43	-	-	-
Total	1,366	112	8,163	225	111
Consumption	2,499	488	11,298	664	1,482
Saving percentage	54.7%	3%	72.3%	33.8%	7.5%

Compatibility with KPLC subsectors is shown in the following table.

Table 6-5: Savings per audit groups and sub-sectors[24]

Reference audit group	KPLC related subsector	Saving ratio
Government building	Office blocks	54.7%
Shopping centres	Combined w/sale & retail trade	3%
Health and hospitals	Hospitals	72.3%
Private buildings	Offices & office suites	33.8%
	Hotels, lodging &boarding houses	
Universities	Universities	7.5%

[24] Source: consultant estimations

6.4 Potential savings of EE - commercial and institutional customers

The saving potential can be roughly evaluated applying the saving rate to the consumption of every KPLC subsectors. The following results are obtained:

Table 6-6: EE savings potential for existing KPLC commercial and institutional customers[24]

	Savings (MWh) in financial Year				
KPLC subsector	2013 / 2014	2012 / 2013	2011 / 2012	2010 / 2011	2009 / 2010
Office blocks	28,997	33,961	32,471	32,435	27,571
Hotels, lodging &boarding houses	17,065	19,226	17,542	18,872	14,666
Combined w/sale & retail trade	1,509	1,865	1,757	1,802	1,544
Hospitals	26,153	28,372	25,206	23,963	20,914
Universities	1,712	1,859	1,646	1,744	1,400
Offices & office suites	3,739	3,138	3,215	2,079	1,050
Total	**79,175**	**88,421**	**81,837**	**80,896**	**67,144**

For all the considered financial years, the rate of potential savings is stable at 35% totalizing about 88 GWh in financial year 2012/2013, i.e. 18 MW at peak with 5,000 h duration of peak use. As these premises are submitted to the same EE regulation as industries, the savings will be captured within ten years (starting from 2019 onwards) – 18 % on the first three-year period, 9% on the second one, 5% on the third and 3% in 2029.

6.5 Potential savings of EE - new commercial and institutional consumers

New commercial and institutional consumers consist of those that have been newly connected after 2014 or those that have substantially increased their demand after that date.

Best practice technology for large buildings today is the positive-energy building, combining strong thermal insulation, efficient design (e.g., shades), lighting, centralized A/C systems, solar water-heaters and electricity generation through solar photovoltaic (PV), cogeneration or wind turbines. It will be considered here that new buildings will together achieve an intermediate performance between zero net energy consumption and 65% of their virtual consumption if they were already built and not optimized. Consequently, they should virtually capture 32.5% savings immediately (assumed from 2019 onwards).

6.6 Results

The following table shows the predictable savings that would result from the above assumptions.

Table 6-7: Expected savings from commercial and institutional sector

Commercial	Kenya	Unit	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Savings rate on existing			-	-	-	6%	6%	6%	3%	3%	3%	1.5%
Savings rate on new			-	-	-	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%
Total savings		GWh	0	0	0	195	214	215	139	141	142	105
Aggregated		GWh	0	0	0	195	409	624	763	904	1,046	1,151
% savings						9%	10%	10%	6%	6%	6%	5%

commercial	Kenya	Unit	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Savings rate on existing			1.5%	1.5%	1%	1%	1%	1%	1%	1%	0%	0%
Savings rate on new			32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%	32.5%
Total savings		GWh	107	109	97	96	100	105	111	117	103	103
Aggregated		GWh	1,257	1,366	1,463	1,559	1,659	1,765	1,875	1,992	2,095	2,198
% savings			5%	5%	4%	4%	5%	5%	5%	5%	5%	5%

6.7 Street lighting

Until recently public lighting has been in poor shape in Kenya because many urban and especially rural households do not benefit from it. Further, vandalism, robbery and fraud have caused failure of many fixtures (up to 40% in Nairobi).

However, various projects to improve the street lighting infrastructure have been started, among others:

- Kenya Power already undertook several projects in for instance Nairobi, Kisumu and Mombasa to upgrade and expand public lighting. These projects mainly consist in installing high – pressure sodium (HPS) lamps to either replace the existing lights or equip new ones and also to replace HPS by less consuming LED lamps as this technology is making quick progress in terms of lighting and energy efficiency.

- German development cooperation and Laptrust, the pension scheme for county government workers in Kenya, have launched the One Million Solar Streetlight Project, aimed at installing 1 million solar powered street lights in all the 47 counties to light up towns, village centres.

Street lighting is and will remain a marginal part of the national electricity consumption (0.4% in 2014), nevertheless it is probably the subsector where the potential for percentage savings is the highest. Combined HPS and LED can easily achieve 50% average energy savings on grid connected lighting when compared to traditional street incandescent lighting. In addition solar technology combined with LED lamp is not using power from the grid and consequently achieves 100% savings.

A recent study by SOL based on the US conditions is demonstrating that equipment and installation costs of new lighting systems are more or less equal for grid-connected and solar public lighting:

Table 6-8: Cost comparison between grid connected and solar public lighting[25]

Grid Connect	Count	Unit cost [USD]	Costs [USD]
Lights & Poles	59	1,050	61,950
Installation	59	800	42,400
Trenching (feet)	5580	40	223,200
Transformer & Base	2	8,000	16,000
Disconnect(s)	4	900	3,600
Total:			347,150

Solar Light Installation	Count	Unit cost [USD]	Costs [USD]
Lights & Poles (GreenWay Series)	76	3,500	266,000
Installation	76	1,000	76,000
Total:			342,000

[25] Source : SOL by Carmanah

In terms of energy efficiency, the above data suggest to recommend the following:

- In the areas with existing public lighting grid-connected systems, the current policy of upgrading incandescent lighting with HPS should go on and progressively be replaced by more efficient LED technology.
- In the areas without grid connection, solar public lighting should prevail in all cases.
- In the areas with grid connection but no public lighting there could be a case by case decision, balancing between long-term costs, capability of the local authorities to pay the electricity bills and risks of vandalism and robbery that are of course more damaging for the solar lighting fixtures.

7 COST BENEFIT ANALYSIS OF ENERGY EFFICIENCY SAVINGS SCENARIO

7.1 Assumptions

This chapter compares the costs and benefits of the analysed and recommended energy efficiency measures for the total system. This will allow to draw a conclusion on the potential effect of such a scenario. However, the saving potentials as well as costs can only be estimates. Further, many effects (e.g. additional positive economic effects of particular measures) cannot be quantified and monetarized. For the sake of clarity this calculation and analysis was kept as simple as possible.

The following assumptions were applied:

Demand scenario and generation expansion:

- The reference scenario of the demand forecast was used as input.
- EE savings potential (which were actually calculated based on the reference scenario) were deducted for each year and customer group as detailed in the previous chapters. The EE saving potential was slightly reduced by up to 3% (towards the end of the planning period) for the sake of conservativeness in this cost benefit analysis.
- Load curves were calculated utilizing adapted load factors for each customer group, leading to a reduced peak demand.
- All other assumptions of the reference scenario were kept (e.g. connections, GDP growth, flagship projects).
- The generation expansion was simulated and optimized applying the same assumptions as for the reference scenario (e.g. fixed CODs for the committed plants) but leading to a different expansion path due to the lower demand growth (mainly a shift of CODs of candidate plants) and dispatch.
- Costs of this scenario were calculated covering CAPEX, OPEX, and fuel costs.

Costs of the EE measures: costs were estimated as detailed in the chapter 7.2 below.

Benefits were identified and considered as follows:

- Reduction of generation costs as calculated in the generation expansion planning.
- Qualitative consideration of reduction of distribution costs as investments in the distribution are assumed to be deferred due to a lower (peak) demand growth (costs for distribution expansion as assumed in the investment planning chapter of the main report of the Power Generation and Transmission Master Plan).

The net present value (NPV) for the base year (2015) was calculated applying a discount rate of 12%.

7.2 Cost estimate for Energy Efficiency measures

7.2.1 Preliminary remarks

It is widely recognized that energy efficiency is by far ahead of the pack of the various means that can be used to balance energy demand and supply. This is true in developed, emerging and developing countries. However the calculation of the true specific costs of an energy efficiency program per saved kWh is not easy because of the following reasons:

- Savings are resulting from a large number of actions that differ in timetable, size and developer. Consequently they cannot be unequivocally identified as specific generation or demand would be.

- The action full cost cannot only be charged on energy efficiency as other goals are concerned: improvement of final product quality, reduction of greenhouse gas emissions, improvement of production process, etc.

Energy efficiency costs can refer either to incentives and controls or to direct implementation.

- Incentive and control are the fields of entities that have no direct access to the objects and methods that can be optimized to generate savings. Nevertheless these entities want to arouse interest of the actors in energy efficiency through regulatory measures, expertise, subsidies or penalties.

- Direct implementation is in the hands of the owners of the energy consuming devices. It is not considered in this study because the utilities and the governmental agencies are not spending them.

7.2.2 Cost of EE incentives and control

The following tables describe and evaluate the costs of incentives and controls to promote energy efficiency in Kenya:

Table 7-1: Detailed costs of incentives and controls

Incentive / Control	Description	Cost analysis
Water heater regulation	See paragraph 3.3 and 8.1 a); large housing must be equipped with solar water heater and checked before connection	New HI customers to be checked before connection: 40 000 KES per control
Industrial / commercial and institutional audits	See Paragraph 3.3; large industrial, commercial, institutional customers to be audited every three years	320 000 KES per audit
Medium size commercial customers audit	See paragraph 8.1 a); Medium size customers to be audited before connection	100 000 KES per audit
Ongoing programs per international institutions, NGOs	See paragraph 3.4	100 MKES per year on average
Ban on instantaneous water heaters	See 8.1b). Subsidy per purchase of not instantaneous water heater for medium size customers to be partially obtained from tax on instantaneous water heater import.	100 000 KES per unit. 1ù of concerned customers per year
Calibration of existing energy services	See 8.1c). Subsidy to adjust equipment for voluntary customers	1% LV customers per year. 10 000 KES per customer
Break-up of EE and RE management and financing	See 8.1 f) Creation of specific EE management and financing team in MOEP, ERC.	20 MKES extra expense per year
ESCO support	See 8.1 g)	
	Training of ESCO staff	10 MKES/year
	Revolving fund	200 MKES every five year
Cogeneration opportunities	See 8.1 h). Study of cogeneration opportunities	50 MKES every ten years

Below the costs are provided for each year and measure on an indicative basis. On a per kWh basis this is roughly 1.3USDcent/kWh (or 1.3KES/kWh) of saved energy. This is below the LEC of the system and the marginal costs of most generation plants. In the next section a comparison of this value with EE analysis in other countries is provided.

Republic of Kenya

Table 7-2: Costs analysis of incentives and controls

million KES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Water heater control	191	193	195	198	200	202	204	206	208	209
Large industrial/commercial audit	190	218	237	257	278	302	328	357	388	423
Small commercial audits	655	499	412	353	782	737	731	698	669	645
Ongoing programs by others	100	100	100	100	100	100	100	100	100	100
Instantaneous water heater ban	477	483	488	494	499	504	509	514	519	524
Calibration of LV services	331	331	331	331	331	331	331	331	331	331
Separation EE/RE	20	20	20	20	20	20	20	20	20	20
Promotion of ESCO	210	10	10	10	10	210	10	10	10	10
Cogeneration opportunities	50	0	0	0	0	0	0	0	0	0
Total costs	2,179	1,859	1,799	1,767	2,224	2,411	2,238	2,241	2,249	2,265
Aggregated costs	2,179	4,038	5,836	7,603	9,827	12,238	14,477	16,717	18,966	21,232

million KES	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Water heater control	211	213	215	216	218	219	221	222	223	225
Large industrial /commercial audit	460	501	546	595	649	708	773	843	921	1,032
Small commercial audits	625	608	705	610	636	665	695	727	761	797
Ongoing programs by others	100	100	100	100	100	100	100	100	100	100
Instantaneous water heater ban	528	532	537	541	544	548	552	555	559	562
Calibration of LV services	331	331	331	331	331	331	331	331	331	331
Separation EE/RE	20	20	20	20	20	20	20	20	20	20
Promotion of ESCO	210	10	10	10	10	210	10	10	10	10
Cogeneration opportunities	50	0	0	0	0	0	0	0	0	0
Total costs	2,489	2,320	2467	2,427	2,512	2,805	2,704	2,812	2,928	3,080
Aggregated costs	23,721	26,040	28507	30,934	33,446	36,250	38,954	41,766	44,694	47,774

7.2.3 International comparison of costs

International benchmarking show a similar order of magnitude for energy efficiency program abroad when taking also into account that these countries are more energy intensive which means that the same measures are saving more energy. Below two examples are given:

- United States of America

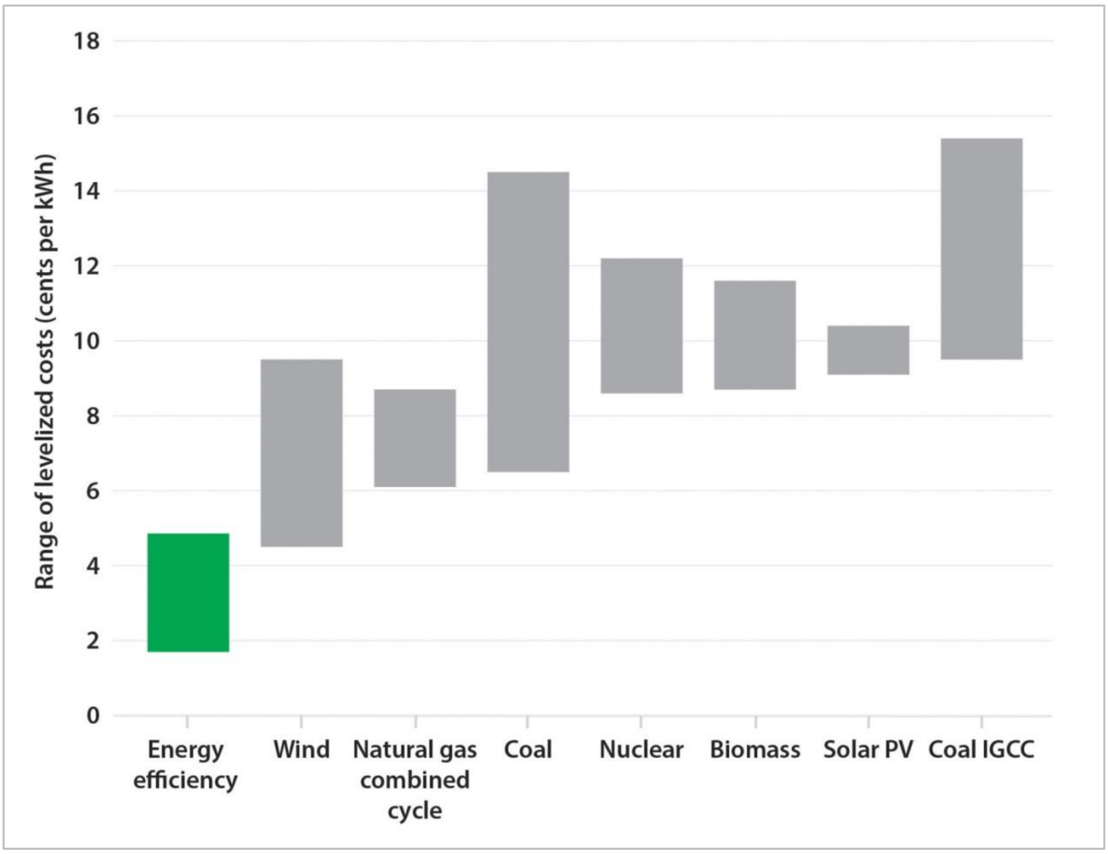

Figure 7-1: Comparative graph of energy efficiency and generation costs in the United States[26]

This means that cost of saved kWh is in the range of 2 to 5 KES per saved kWh.

[26] Source :American Council for an Energy Efficient Economy (ACEEE)

- Republic of South Africa[27]

  The government of South Africa decided to include an environmental levy in electricity tariffs to fund the implementation of Energy Efficiency and Demand-Side Management (EEDSM) programs. Energy efficiency is now included as a resource of choice in integrated planning for future energy resources. The phase of funding allowed in the three-year Multi-Year Price Determination (MYPD) was ZAR 5,445 million (USD 674 million) with the goal of gross saving 1,037 MW and a cumulative annualized total of 4,055 GWh from 2011 to 2013.

  This means a cost of 5.5 US cents per KWh equivalent to 5.5 KES per saved kWh.

7.3 Results of cost benefit analysis

The following results for the EE scenario were calculated:

- Costs for EE measures amount to a net present value of mUSD 150 (nearly mUSD 500 if not discounted). On a per kWh basis this is roughly 1.3 USDcent/kWh (or 1.3 KES/kWh) per saved kWh electricity.

- The EE scenario - compared to the reference scenario - leads to a reduction of total generation costs by 7% (roughly a NPV of USD 800 million). This is considerably above the estimated costs for EE measures. This means that for the same output (i.e. benefit of electricity utilisation such as same GDP growth, industrial production and use of household appliances) only a reduced input (consumption of electricity) is needed (i.e. for lower supply costs). If EE costs are added to the total costs the reduction for the EE scenario is 6%. The ratio of benefits (generation cost reduction) and costs (for EE measures) is above 5.

- The reduction applies to all cost positions, but are highest for fuel (-13%) and lowest for variable OPEX (-1%). Variable OPEX are only slightly reduced probably because they contain the take or pay supply through the HVDC interconnector with Ethiopia. CAPEX and fixed OPEX are reduced by about 6% each.

- However, the LEC of the system may increase slightly by 7%. This is obvious since the LECs are calculated for a considerably lower electricity consumption (reduced by 10%, discounted) which exceeds the net reduction of costs. The costs are not expected to decrease to the same extent as the consumption because more excess electricity will be generated (for export or to be dumped) due to system requirements (such as minimum capacity and reserve requirements). For the total study period, some 100% more excess electricity is estimated. This effect is strongest during the period 2019 to 2024 where an overcapacity of committed plants may appear. If the excess energy can be used and not dumped (in both the reference and EE scenario) the LECs are even closer. If EE measures are applied to a higher demand scenario this excess

[27] Source Energy Efficiency Country Study : Republic of South Africa ; Ernest Orlando Lawrence Berkeley National Laboratory

electricity is expected to decrease and the EE scenario will be even more beneficial. The same is true if excess energy is lower (e.g. due to a delay of generation projects).

- If deferred investment costs in the distribution system were considered due to the annual reduced peak load these benefits could even lead to a reduction of the LEC of the EE scenario to only 3% above the level of the reference scenario.

- Concluding, despite slightly higher LECs the recommended EE measures and the assumed effect would be beneficial: overall system costs would be reduced while the utilisation of electricity would remain the same. There are further potential benefits such as environmental effects from fuel savings and technological edge which were not included in the calculation.

8 RECOMMENDATIONS AND ENERGY EFFICIENCY PLAN

8.1 Recommendations for additional EE actions

Kenya's current policy for energy efficiency in the power sector is ambitious and ubiquitous, although the main challenge is to fulfil implementation by the electricity users. However, a few additional measures can be suggested based on the present study:

- Initial checking for new customers - a regulation should stipulate that new large customers are constrained to submit their project design to EE expertise to obtain connection or for reinforcement of their existing connection. This measure is in line with the assumption that new customers immediately conform to efficient equipment and practice.

- Instantaneous water heaters are noxious for the generation, transmission and the distribution networks as they concentrate high power demand at the same periods. By doing so, they generate high losses, voltage drops and call for expensive generation means. Consequently, instantaneous water heater import and retail should be prohibited as soon as possible. The recommendation is aiming at reducing peak power demand (not energy) through service current limitation and import prohibition. To mitigate any negative effects on consumers or bypassing this regulation should be implemented in a transparent and sensitive manner. This could be for instance by a step by step approach targeting areas with warmer climate first or providing information and programs on suitable substitutes. The alternative solutions are expensive or inaccessible for the low income customers (e.g. solar water heaters, geysers, gas heaters). However the savings are such for the utilities that subsidies should be considered for geyser purchase for instance. The limitation of the service current is also a condition for applying time of day tariffs in the domestic sector.

- Complementing the previous measure, new LV (low voltage) services should be equipped with calibrated circuit breakers or switches strictly limiting the intensity of the customer's current. This would impede the use of instantaneous water heater, numerous incandescent bulbs and other high existing non optimal devices. This measure could also apply to any customer replacement in the connected premises.

- KAM/CEEC audits often miss critical data. As part of the process to improve the audit quality, KAM should organize audit writing training sessions to correct this anomaly. A mandatory refreshment (e.g. every three years) should be considered in order to keep the same level of quality for all auditors. This would also provide a forum to roll out new audit standards and gather hands on feedback from the audits.

- Additionally, KAM/CEEC should to communicate the details of studies in a more consistent and comprehensive manner. This will facilitate sharing of good practices and information management and monitoring.

- Common EE/RE/access financing credit lines and management are generally harmful to energy efficiency as this study noted several times. It happens that the whole credit line is dedicated to the other two purposes. Government bodies and financial institutions should carefully separate the amount devoted to each objective and, if possible, appoint distinctive managers.

- A single ESCO is currently operating in Kenya (see section 3.5). Annex 8.A reviews international ESCO experience in developing countries. Action should be undertaken to overcome the identified barriers, in particular with regard to their specific and often high risk for capital and resulting availability of financing. This includes providing financial support (e.g. tax relief), ensuring enabling regulations and laws (e.g. protection of property), developing human resources, disseminating information about the ESCO mechanism, undertaking ESCO certification and simplifying the administrative contracting process.

- The available audits pay little attention to co-generation activities, both from the generation and the consumption point of view, despite the fact that a few sectors could be potential co-generators (petroleum refineries, sugar, pulp and paper, breweries and agro-industries). This may be due to satisfactory existing equipment or absence of confirmed profitable capacity. However KAM should undertake a specific and extensive review of the cogeneration opportunities in industry either for self-consumption or electricity retail.

The following table shows a synthetic analysis of the above recommendations and proposed actions:

Table 8-1: Synthesis of recommendations and proposed actions

#	Action	Time horizon	Impact	Target	Undertaker	Other
1	Pre-connection audit of new customers	Permanent measure	Immediate reduction of energy and peak consumption	All medium and large new and expanding customers	Certified auditors on behalf of the customers	Satisfactory Audit certificate necessary to obtain permanent electrical connection
2	Elimination of the instantaneous water heaters	Medium term measure	Reduction of global and local peak demand	Domestic consumers	KPLC Retailers Customs Customers	Concessional loans/subsidies to facilitate access to SWH or geysers
3	Power connection limits	Permanent measure	Reduction of global and local peak demand	Domestic customers	KPLC	Calibrated CB, switches or fuses inserted in connection
4	Improvement of the quality of the audit reports	Immediate/medium term measure	Facilitation of audit understanding/follow-up and EE planning	Designated small, medium and large customers	EE Training facilities, auditors	Periodical check-up of the reports produced by the certified auditors, re-

#	Action	Time horizon	Impact	Target	Undertaker	Other
						port writing trainings and mandatory refreshments
5	Increase transparency of the audit policy	Immediate measure	Improved feedback on the EE management	KAM, ERC	MOEP	Annual quantified report of KAM savings per sub-sector
6	Separate EE and RE management and financing	Immediate/ medium time measure	More attention and funding dedicated to EE	Government, public agencies, IGO	MOEP	RE is more “attractive” than EE
7	Develop ESCO industry in Kenya	Medium time measure	Facilitate EE implementation	Medium and large customers	Private initiative, banking sector, ERC, IFIs, MOEP	Attract large international service companies to create subsidiaries in Kenya, call for negawatt tenders…; removing barriers through regulations and incentives
8	Investigate cogeneration opportunities	Medium time measure	Prepare auto-consumption and power retail projects	Steam producers and users, biomass producers	KAM and certified auditors	To be proposed to IGO for funding

8.2 Demand-side management

Strictly speaking, demand-side power management is not the same as energy efficiency. In some schemes it may actually increase the volume of energy consumed while reducing its cost. DSM has been used for a long time in more or less sophisticated ways, including dispatch operations. The most elementary DSM consists of using time-of-day tariffs to discourage customers from consuming at peak hours. The tariff change is triggered either by a clock linked to or integrated in the customer’s meter or a signal carried by the grid or telecommunication network. Customers can directly use the signal to either switch on or switch off selected appliances (water heaters, geysers, heating, pumping, etc.). More sophisticated approaches are used for instance by EDF (France): the scheme Tariff EJP (Effacement Jour de Pointe, load-shedding peak days) included very high prices on 22 days per year with one day advance notice. In return, lower than average prices were applied for the rest of the year. The French TSO (RTE) now automatically disconnects non critical appliances (refrigerators, A/C and heating systems) for a short period of time to cope with unexpected constraints in selected areas (Voltalis system in Brittany). Today, operators are thinking of associating this type of voluntary dispatched load management with intermittent generation (wind, solar systems). This approach is generally recognised as being "smart grid".

These various types of DSM could apply to Kenya. However, the lowering of demand peaks due to efficient lighting and conversion of water heaters from electric to solar, can reduce the benefits of such initiatives in the residential sector. However, these options remain valid for the large consumers. A previous test of off-peak (interruptible) tariffs resulted in a turnover loss for KPLC. Tariffs were subsequently increased which again led to reduced consumption under the off-peak tariff. Tariffs should consequently be carefully designed to avoid similar failures.

DSM deployment is not a stand-alone activity. It must be closely associated with optimizing the energy mix as a negawatt generator, an alternative option to expensive peak generation.

Predictive analysis of the impacts on peak and load factors of the different tariff interventions listed in the table below is difficult through international comparisons. As mentioned before, the previous attempt to introduce time-of-day tariffs in Kenya gave a fair indication of its customer appeal. International feedback is poor because the measures have either never been implemented (short-notice yearly load shedding, smart grid) or when they have been applied for a long time this has been in a very different context. The most relevant way to predict tariff relevance and customer sensitivity is to test different interventions on samples of customers of e.g. predefined subsectors or selected (critical) substations.

The following table presents an overview of the DSM measures explained above.

Table 8-2: Overview of DSM measures

#	Action	Time horizon	Impact	Target	Undertaker	Means
1	Tariff testing on samples of customers.	Medium term measure	Evaluation of customer sensitivity to prices difference and capacity to adjust consumptions	Urban LV customers, MV customers with distinctive options	KPLC, KETRACO	Specific meters and remote transmission Involvement of local electricians
2	Time-of-day tariffs	Medium term measure	Reduction of daily peak.	All customers	KETRACO, KPLC	Electronic meters,
3	Incentive to voluntary load shedding on specified periods	Medium term measure	Additional reduction of yearly peak	Medium and large customers with autonomous generators	KETRACO, KPLC	Electronic meters with remote transmission

#	Action	Time horizon	Impact	Target	Undertaker	Means
4	Voluntary load shedding with short notice	Long term measure	Additional reduction of yearly peak and mitigation of unpredicted constraints	All customers	KETRACO dispatching	Dedicated CB in the customers' premises activated by the dispatching signals
5	Smart grid	Long term measure	Combined optimization of demand and supply	All customers	KETRACO automatic dispatching	DSM is a real time way of optimizing the energy mix.

8.3 Logical framework and work plan for energy efficiency

8.3.1 EE logical framework

The energy efficiency logical framework is a part of overall efficiency. Its specific logical framework is included in the overall logical framework as a fourth rank finality as shown in the graph below.

The specific EE logical framework consists of the same finality applied to the various subsectors.

External variables must then be defined. These cover the factors that cannot be influenced by the specific actions: either EE stakeholders do not manage relevant activities that have impact on these variables (variables A) or the Kenyan power sector alone cannot influence such variables (variables B).The table below presents a list of such external variables A and B that may not be exhaustive:

Table 8-3: List of external variables

External variables A		External variables B	
Demand scenario	Change EE potential calculation	Climate	Expand/reduce EE potential
GDP	Change actual EE potential	Cost of fossil fuels	Change EE attractiveness
Import tariffs	Change access opportunity	New appliance technologies	Expand EE opportunities
Kenya fiscal policy	Change EE attractiveness	Value of CO2 emissions	Change EE profitability
Interest rates	Change EE funding resources	IFI policies in the power sector	Change access to EE financing
Quality of power supply	Change power appliance attractiveness	New generation technologies	Change EE attractiveness
Availability of natural gas	Increase EE opportunities in the power sector		

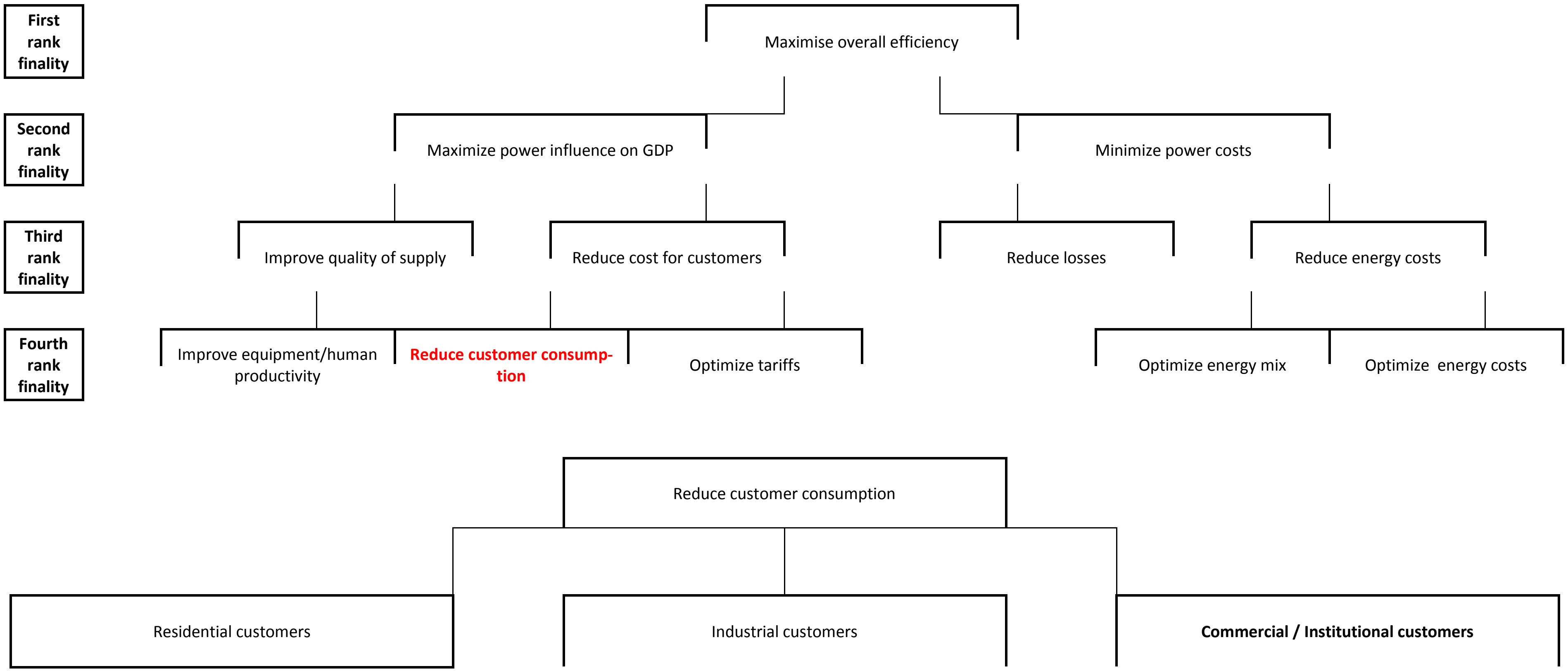

Figure 8-1: Hierarchy of EE and Overall logical framework

8.3.2 Energy efficiency work plan

The energy efficiency work plan covers the activities mentioned in paragraphs 3 to 6. It is assumed that the implementation of these activities will result in achieving the predicted savings shown in the same paragraphs.

The following table summarises the activities that have been implemented and advocated so far.

Table 8-4: Energy efficiency work plan

#	Activity	Status	Stakeholders	Target
1	Develop and implement sustainable awareness and sensitization programs on energy efficiency and conservation	To develop	KPLC[2], MOEP, ERC	all subsectors
2	Develop and enforce minimum energy performance standards (MEPS) and rating labels	Partially in place	GEF, ERC	all subsectors
3	Provide appropriate fiscal and other incentives for EE	To develop	MOEP, National Treasury	all subsectors
4	Establish an Energy Efficiency and Conservation Agency (EECA)	To develop	MOEP	all subsectors
5	Solar water heater regulation	In place	ERC	residential
6	Large consumers audit and implementation policy	In place	ERC	industrial, commercial, institutional
7	Enforce building codes to enhance the concept of green design in buildings	To develop	UN Habitat, MOEP	commercial, institutional
8	Replace incandescent lamps (ICLs) with Compact Fluorescent Lamps (CFLs)	To replicate	AFD, KPLC,…	residential
9	Upgrade skills in energy management.	To develop	AEPEA, universities, KAM, EECA	all subsectors
10	Smart metering	To develop	KPLC	all subsectors
11	Financing initiatives	To develop	Donors, private sector	industrial, commercial, institutional
12	Promote ESCO industry	To develop	Donors, private sector	industrial, commercial, institutional
13	New technology in street lighting	To develop	local authorities, donors, ESCOs	commercial, institutional

#	Activity	Status	Stakeholders	Target
14	Regulation for new customers	To develop	ERC, KPLC	all subsectors
15	Prohibit instantaneous water heaters	To develop	ERC	residential
16	Calibrate LV services	To develop	KPLC	residential
17	Improve KAM audits through enhanced trainings and mandatory refreshments	To develop	KAM	industrial, commercial, institutional
18	Enforce KAM transparency	To develop	KAM	industrial, commercial, institutional
19	Dissociate RE and EE management and financing	To develop	MOEP, ERC, donors	all subsectors
20	Expand cogeneration	To develop	KAM, ESCOs	industrial,
21	Focus on DSM	To develop	KPLC, KETRACO	industrial, commercial, institutional

ANNEX 1 EXECUTIVE SUMMARY – ANNEXES

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ANNEX 2 INTRODUCTION – ANNEXES

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Republic of Kenya

ANNEX 3 BACKGROUND AND POLICY ANALYSIS – ANNEXES

Annex 3.A RISE Readiness for Investment in Sustainable Energy – World Bank

The following tables are extracted from RISE website: (http://rise.worldbank.org/data/exploreeconomies/kenya/2014#1) (accessed 04/27/2015).

All of the following are the detailed results and indicators as established by the RISE survey (carried out between December 2013 and July 2014). The Consultant did not modified original data and did not make additional contribution.

Annex Table 1: Energy Efficiency Planning (RISE analysis)

Planning Activities	Note / situation
NATIONAL PLAN FOR INCREASING ENERGY EFFICIENCY	**LOW**
Is there an energy efficiency target at the national level?	No
Does the energy efficiency plan include targets on the following?	...
Supply side target	No
Residential target	No
Commercial target	No
Industrial target	No
Is there a national energy efficiency legislation and/or an action plan?	No
ENTITIES FOR ENERGY EFFICIENCY POLICY, REGULATION AND IMPLEMENTATION	**MEDIUM**
Are there governmental or independent bodies concerned with the followings?	...
Setting energy efficiency strategy/policy	Yes
Setting energy efficiency standards	Yes
Regulating energy efficiency activities of energy suppliers	No
Regulating activities of energy consumers	Yes
Certifying compliance with equipment energy efficiency standards	Yes
Certifying compliance with building energy efficiency standards	No

Source: (http://rise.worldbank.org/data/exploreeconomies/kenya/2014#1) (accessed 04/27/2015)

Annex Table 2: Status of Policies and Regulations (RISE analysis)

Policies and Regulations Activities	Note / situation
QUALITY OF INFORMATION PROVIDED TO CONSUMERS ABOUT ELECTRICITY USAGE:	**MEDIUM**
Do consumers receive reports of their electricity usage?	Yes
If yes, at what intervals do they receive these reports?	Monthly
If yes, do the reports include price levels?	Yes
If yes, do customers receive a bill or report that shows their electricity usage over time?	No
If yes, do customers receive a bill or report which compares them to other users in the same region and/or class?	No
Do utilities provide customers with information on how to use electricity more efficiently, whether through bills or other means?	Yes
INCENTIVES OR MANDATES FOR ENERGY SUPPLY UTILITIES TO INVEST IN ENERGY EFFICIENCY	**LOW**
Are utilities required to carry out energy-efficiency or carbon-reduction activities?	No
If yes, are there penalties in place for non-compliance with utility EE or carbon-reduction mandates?	n/a
If yes, are energy savings measured to track performance in meeting EE or carbon-reduction mandates?	n/a
If yes, are measured energy savings or carbon-reductions validated by an independent third party?	n/a
If yes, is there a mechanism for utilities to recover costs associated with or revenue lost from mandated demand-side management activities?	n/a
INCENTIVES OR MANDATES FOR PUBLIC ENTITIES TO INVEST IN ENERGY EFFICIENCY	**MEDIUM**
Are there binding energy savings obligations for the following?	...
Public buildings	Yes
If yes, are energy savings from efficiency activities at public buildings tracked?	Yes
Other public facilities (may include water supply, wastewater services, municipal solid waste, street lighting, transportation, and heat supply)	Yes
If yes, are energy savings from efficiency activities at other public facilities tracked?	Yes
Is there a policy in place for public procurement of energy-efficient products and services? (N: at national level / M: at municipal level)	No
Can public entities engage in multi-year contracts with service providers?	Yes
Do public budgeting regulations and practices allow public entities to retain energy savings at the following level?	...
At the national/central level	No
At the municipal level	No
INCENTIVES OR MANDATES FOR LARGE-SCALE USERS TO INVEST IN ENERGY EFFICIENCY	**HIGH**
Are there energy-efficiency mandates for large energy users?	Yes
If yes, are there penalties in place for non-compliance with regulatory obligations for energy efficiency?	Yes
If yes, is there a measurement and verification program in place?	Yes

Policies and Regulations Activities	Note / situation
If yes, is it carried out by a third party?	Yes
Are energy efficiency incentives in place for industrial customers?	Yes
MINIMUM ENERGY EFFICIENCY PERFORMANCE STANDARDS	**LOW**
Have minimum energy efficiency (performance) standards been adopted for the following products?	...
Appliances	No
Lighting	No
Electric motors	No
Industrial equipment	No
Is there any provision for regular updates to the energy efficiency standards?	n/a
Is there a penalty for non-compliance with energy efficiency standards?	n/a
ENERGY LABELING SYSTEMS	**LOW**
Have energy efficiency labelling schemes been adopted for the following products?	...
Appliances	No
Lighting	No
Electric motors	No
Industrial equipment	No
BUILDING ENERGY CODES	**LOW**
Are there energy codes for the following:	...
New residential buildings	No
If yes, is there any provision for regular updates to the energy code for residential buildings?	n/a
New commercial buildings	No
If yes, is there any provision for regular updates to the energy code for commercial buildings?	n/a
Is there a system to ensure compliance with building energy codes?	No
Are renovated buildings required to meet a building energy code, in the following sectors?	...
Residential	No
Commercial	No
Is there a standardized rating or labelling system for the energy performance of existing buildings?	No
Are commercial and residential buildings required to disclose property energy usage at the point of sale or when leased?	No
Are large commercial and residential buildings required to disclose property energy usage annually?	No

Source: (http://rise.worldbank.org/data/exploreeconomies/kenya/2014#1) (accessed 04/27/2015)

Annex Table 3: Pricing and Subsidies situation (RISE analysis)

Activities	Note / situation
INCENTIVES FROM ELECTRICITY PRICING	**MEDIUM**
What types of electricity rate structure do the following customers face?	...
Residential customers (F: Flat fee per connection / C: Constant block rates / D: Declining block rates / I: Increasing block rates)	I
Industrial customers (F: Flat fee per connection / C: Constant block rates / D: Declining block rates / I: Increasing block rates)	C
Commercial customers (F: Flat fee per connection / C: Constant block rates / D: Declining block rates / I: Increasing block rates)	C
Which of the following charges do large electricity customers in the following sector pay? Please check all that apply.	...
Industrial sector (E: Energy (kWh) / D: Demand (kW) / R: Reactive power (kVAr))	E, D
Commercial sector (E: Energy (kWh) / D: Demand (kW) / R: Reactive power (kVAr))	E, D
FOSSIL FUEL SUBSIDY	**HIGH**
What is the proportion of electricity generation by subsidized fossil fuel?	0%
CARBON PRICING MECHANISM	**LOW**
Is there a legally binding greenhouse gas emission reduction target in place?	No
If yes, is there any mechanism to price carbon in place? (e.g. carbon tax, auctions, emission trading system)	n/a
RETAIL PRICE OF ELECTRICITY	
What is the unit price of electricity for average residential consumption? (US$/kWh)	0.145
What is the unit price of electricity for industrial consumption of 10,000 kWh per month? (US$/kWh)	0.184

Source: (http://rise.worldbank.org/data/exploreeconomies/kenya/2014#1) (accessed 04/27/2015)

Annex Table 4: Notes

NOTES	PERFORMANCE SCORES
High	High performance: Score in the upper quartile
Medium	Medium performance: Score between the upper and lower quartiles
Low	Low performance: Score in the lower quartile
N/A	Not applicable. Country was not assessed for its performance on energy access because the country does not have energy access issues.
-	There is no RISE Energy Efficiency indicator for Procedural Efficiency

Source: (http://rise.worldbank.org/data/exploreeconomies/kenya/2014#1) (accessed 04/27/2015)

Annex 3.B Detailed EE regulation

1) Solar Water heating regulations (ERC, May 2012)

Solar Water heating regulations impose the following:

- All premises within the jurisdiction of local authorities with hot water requirements of a capacity exceeding 100 litres per day shall install and use solar heating systems.
- All existing premises with hot water requirements of a capacity exceeding 100 litres per day shall install and use solar heating systems within a period of five years from the effective date of 25th may, 2012
- All new premises designs and extensions or alterations to existing premises should incorporate solar water heating; therefore the owner of a premises, architect and an engineer engaged in the design, construction, extension or alteration of premises shall incorporate solar water heating systems therein;
- An electric power distributor or supplier shall not provide electricity supply to premises where a solar water heating systems has not been installed in accordance with the Regulations;
- The design, installation, repair and maintenance of a Solar Water Heating System shall be in accordance with the Code of Practice Solar Water Heating for Domestic Hot Water; Kenya Standard KS 1860;2008 and the Building Code made under the Local Government Act;
- The Solar Water Heating Regulations will be implemented in liaison with the local authorities responsible for implementing Section NN31.5 of the Planning and Building Regulations, 2009
- A person shall not undertake any solar water heating system installation work unless the person is licensed by the Energy Regulatory Commission as a solar water heating system Technician or Contractor.

2) Amendment to the Energy Act concerning large consumers Energy Efficiency

- The owner or occupier shall cause an energy audit of the facility to be undertaken by a licensed energy auditor at least once every three years.
- The report of the audit undertaken under paragraph (1) shall be in the form set out in the Second Schedule.
- The owner or occupier shall submit the report of the audit to the Commission in a manner approved by the Commission, within six months from the end of the financial year in which the audit is undertaken.
- The Commission shall examine the report submitted hereunder and if dissatisfied therewith, may require the concerned owner or occupier of a facility, at his own cost, to engage an independent energy auditor from a list of names provided by the Commission to undertake an energy audit.
- An energy auditor shall upon completion of an audit execute a quality assurance declaration in the form set out in the Third Schedule.
- The Commission or its agent may subject the energy audit report to verification after giving not less than fourteen days' notice to the facility owner or occupier.
- An owner or occupier of designated facilities shall within six months from the end of the financial year in which an energy audit is undertaken, prepare and submit to the Commission an

energy investment plan for the next three years, setting out proposals for the conservation of energy during that period.

- An energy investment plan shall be reviewed after every three years.
- The owner or occupier shall take measures to realize at least fifty percent of the identified and recommended energy savings specified in the energy investment plan by the end of three years and thereafter at every audit reporting date.
- An owner or occupier to whom these Regulations apply may investigate the inclusion of the relevant components of an energy investment plan into a project to be registered under the clean development mechanisms or any other carbon finance mechanism which may be in place from time to time.
- Every designated facility shall submit an annual implementation report as provided in the Fourth Schedule.
- A facility owner or occupier who fails to submit an implementation report within the stipulated time shall be liable to a penalty not exceeding thirty thousand shillings for each day or part thereof that the breach continues.
- The Commission or its agent may conduct an inspection to verify compliance with the implementation report.
- The Commission shall issue a compliance certificate on request by facilities complying with these regulations.
- Notwithstanding regulation 6, the Commission or its agent may, after giving not less than fourteen days' notice to the facility owner or occupier, undertake an energy audit at its own cost.
- The owner or occupier shall allow the Commission or its agent access to the facility for purposes of such audit.
- A person shall not carry out an energy audit under these regulations unless he is licensed as an energy auditor by the Commission.
- An organization shall be licensed as an energy audit firm if it is registered in Kenya and has in its employment at least one licensed energy auditor."

Annex 3.C Presentation of a Kenyan ESCO: Lean Solution Group

Lean Solutions Group This is a reputable group mainly involved in Project management within Africa, and especially in East Africa. We have been helping companies and organizations diversify their energy sources and especially go for Green Energy. We have provided consultancy into Green Energy such as Micro-Hydro Projects, Solar Photovoltaic (PV) systems, and Briquettes. Also, we offer consultancy in Energy Management to help clients save substantially on their Energy costs. Following are our companies under Lean Solutions Group;

- Lean Energy Solutions Ltd.
- Lean Solutions Tanzania Ltd.
- Lean Solutions, Nairobi.

Lean Energy Solutions Limited Lean Energy Solutions Limited, which is ISO 9001 Company, is one of the pioneers in both Project and Energy Management consultancy services in East Africa which includes Comprehensive Energy Audits, Investment Grade Audits, manufacturing of Lean Briqs (briquettes) and thus other related projects such Boiler Conversion from Fossil fuel fired to Lean Briqs (Briquettes) fired and conversion of furnaces from LPG/IDO to Lean Briqs (Briquettes) fired.
Lean Solutions, Nairobi At Lean Solutions, Nairobi, we help the organizations to improve productivity and maximize bottom line performance by implementing specially designed quality improvement & quality maintenance system. The packages offered are the following time tested and widely accepted methodology in order to ensure sustainable competitive advantage for the organization.

- Gemba Kaizen Methodology – The Japanese philosophy of continual improvement
- ISO 9000 – Quality Management Systems

Lean Solutions (T) Ltd, Dar-e-Salaam
At Lean Solutions (T) Ltd we offer both energy management program provided through Lean Energy Solutions and Gemba Kaizen and ISO 9000 program.

Our Main Products and Services

a. Boiler Conversion from Oil fuel fired to solid fuel fired Lean Energy is a pioneer company in Kenya that converts Boiler from fossil fuel fired to Lean Briqs Fired. We reduce the cost of steam generation by converting their boilers from oil fired to solid fuel fired on BOOT basis (Build, Own, Operate and Transfer) for a contractual period of 7 to 10 years depending upon the investment. We undertake the project of completely transforming client's boiler by installing furnace, preheater, induced draft fan and other accessories. This is ensured through constant supply of the briquettes, firing of briquettes and smooth generation of steam as per client's requirements.
b. Manufacturing of Lean Briqs (Briquettes) Lean Energy has procured, installed and commissioned a briquetting machine to use biomass in Muhoroni to manufacture Lean Briqs (Briquettes) to help curb the rising costs of fossil fuels. **c. Energy Audits** We identify the cost-effective options to improve the energy efficiency on all facilities e.g.

THERMAL ENERGY AUDIT

- Boilers, Heaters, Thermo-packs & Furnaces
- Waste Heat Recovery
- Cogeneration

ELECTRICAL ENERGY AUDIT

- Chilled Water Plants
- HVAC system
- Motors & Pumping Audit
- Power Transmission & Distribution
- Multi-fuel Substations
- Lighting Audit

COMPRESSED AIR SYSTEM AUDIT

- Air Compressor Performance & efficiency check
- Energy study
- Leakage study

SUPPLY AND CONSULTANCY ON GREEN ENERGY PROJECTS/ PRODUCTS:

- Micro-Hydro Projects
- Solar Photo Voltaic
- Solar Water Heating
- Co-Generation Plants
- Producer Gas Projects

Biogas Projects

ANNEX 4 POTENTIAL OF EE IN THE RESIDENTIAL SUBSECTOR – ANNEXES

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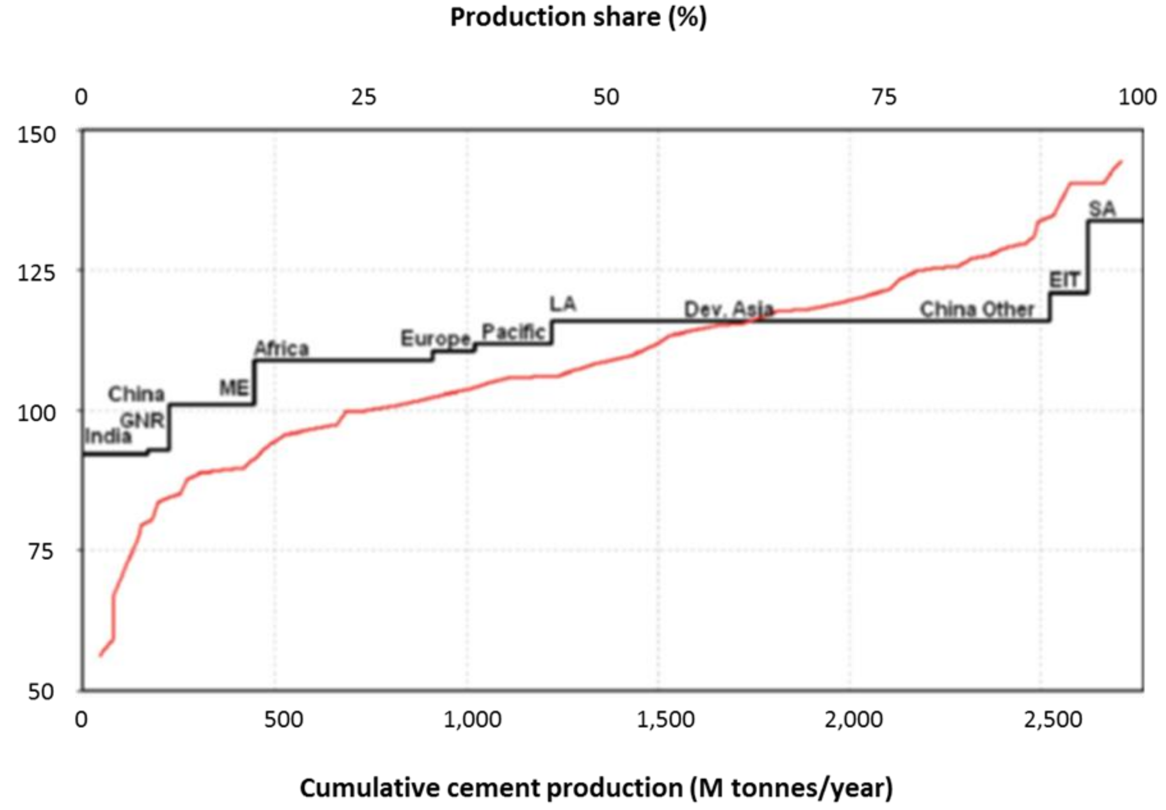
ANNEX 5 POTENTIAL OF EE IN THE INDUSTRY SECTOR – ANNEXES

Annex 5.A Cement and Iron/Steel UNIDO energy efficiency analysis

The following figures are extracted from the reference GLOBAL INDUSTRIAL ENERGY EFFICIENCY BENCHMARKING (November 2010, UNIDO).

Cement industry

The following graph is depicting the average volume of electricity (black curve) used to produce one ton of clinker in kWh according to various parts of the world. India and China are leading the pack with about 92 kWh/t. Africa average consumption is equivalent to 110 kWh/t, thus showing an average of 16% potential saving for 10% of the world production (red curve).



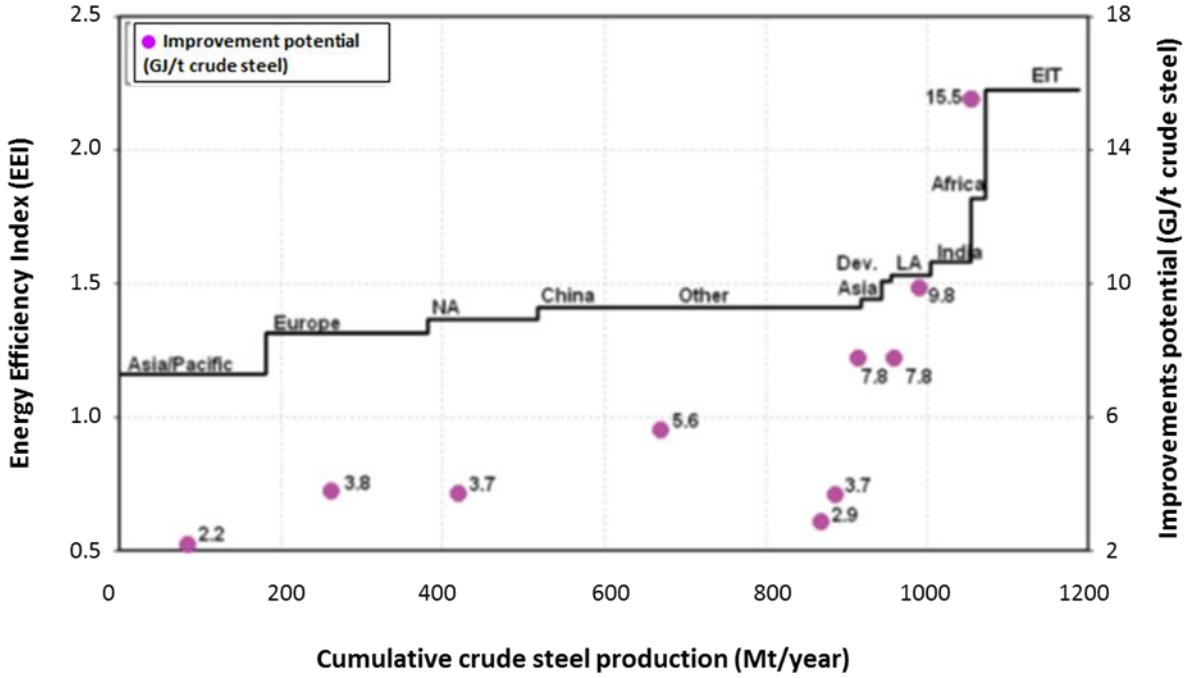
Source: Global industrial energy efficiency benchmarking (November 2010 - UNIDO).

Annex Figure 1: Benchmarking of specific electricity consumption for cement production

Iron and steel industry

Concerning iron and steel, the report does not mention specific electricity consumptions. Only Energy Efficiency Index (EEI) is provided. Asia-Pacific steel industry is the most efficient with EEI at 1.15 while the small African steel sector EEI is about 1.8.That would suggest 36% potential savings.

However, this number may not reflect the specific electricity potential savings and a more conservative value should be adopted.



Source: Global industrial energy efficiency benchmarking (November 2010 - UNIDO).

Annex Figure 2: Benchmarking of EE improvement potential for crude steel industry

ANNEX 6 POTENTIAL OF EE IN THE COMMERCIAL SECTOR – ANNEXES

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ANNEX 7 COST BENEFIT ANALYSIS OF EE SAVINGS SCENARIO – ANNEXES

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Republic of Kenya

LAHMEYER INTERNATIONAL

ANNEX 8 RECOMMENDATIONS AND ADDITIONAL REMARKS – ANNEXES

Annex 8.A Feedback on ESCO experience in developing countries

This annex is based on a report by the International Institute for Sustainable Development (IISD) from May 2010.

As shown in the following table developing countries with an established ESCO industry are not numerous. In Africa, only two countries are mentioned and Kenya is one of them with a single ESCO that is mentioned in this report (LEAN Energy Solutions, Annex 3.C). South Africa is nevertheless ranked 4th in terms of investment behind China, South Korea, Brazil.

Annex Table 5: Inventory of ESCOs in developing countries (as per June 2010)

Country	Number of ESCOs	Number of Projects	Total Investment	Main Assistance Received	ESCO Association
China	Over 400 with 50-60	1426 Since 1998	$260 million in 2006 $1 billion in 2007	World Bank GEF	Yes/EMCA
Brazil	25-40		$40 million/year in 2008	World Bank Three Country Energy Efficiency project, Domestic government	Yes/ABESCO
South Korea	125	519 in 2000	$76 million in 2000	Domestic government	-
Thailand	24		-	World Bank GEF, Domestic government	Yes
South Africa	35	-	$10 million in 2001	Domestic utility	Yes/SAAEs
India	20	-	$1 million in 2001	World Bank GEF, Domestic government and banks, USAID, CDM	Yes/ICPEEB
Mexico	20	-	-	United States National Renewable Energy Laboratory, Domestic government	-
Kenya	1	-	-	World Bank GEF	No

Source: IISD Report about ESCOs in developing countries

ESCO typical activity consists of third party financing equipment and product management assistance designed to reduce the energy bills of large energy customers. They make money through performance contracting over a fixed period of time. Either a private bank or a financial institution loan is often associated in the process as the ESCOs do not have enough financial standing but are supposed to minimize the risks for the lender through adequate technical assistance to the final users.

However this paradigm is often extended in the developing countries to fixed fee contracting to cover at least a portion of the pre-financing. Leasing is often considered instead of equipment purchasing. In addition concessional financing are always in the loop either through International Financial Institutions (World Bank) or funding of State agencies as can be seen in the table above.

Nevertheless IISD report identifies many barriers to overcome to guarantee ESCO viability over the long term:

- Difficulties to access financing
- High administrative and transaction costs
- Government energy policy disincentives
- Limited knowledge of ESCOs and reliability concerns
- Lack of human resources
- Client preferences for in-house solutions and other priorities
- Challenges of the classical EPC business model

Each of this barrier must be addressed to promote the ESCO business in Kenya. To a certain extent LEAN Energy Solutions innovative approach is a fair example of what could be realized in the country.