

FINAL REPORT - GUIDELINES FOR DEMAND-SIDE MANAGEMENT

Consultancy services to implement harmonised regulatory/technical frameworks and synthesised renewable and energy efficiency strategies in the EA-SA-IO region

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This assignment will support the Common Market for Eastern and Southern Africa (COMESA), East African Community (EAC), Intergovernmental Authority on Development (IGAD), Indian Ocean Commission (IOC), and Southern African Development Community (SADC), in their collective efforts to promote the development of a sustainable regional energy market in the Eastern Africa, Southern Africa, and Indian Ocean (EA-SA-IO) region.

Report

This report presents a snapshot of existing demand side management (DSM) programs in the targeted regions and formulates guidelines for accelerating the adoption of DSM programs in the EA-SA-IO region.

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Opinions and Limitations

Unless otherwise indicated, the opinions herein are those of the authors and do not necessarily reflect the views of COMESA, EAC, ESREM, IGAD, IOC, or SADC.

CPCS makes **deliberate efforts to validate data obtained from third parties, but CPCS cannot warrant the accuracy of all data.**

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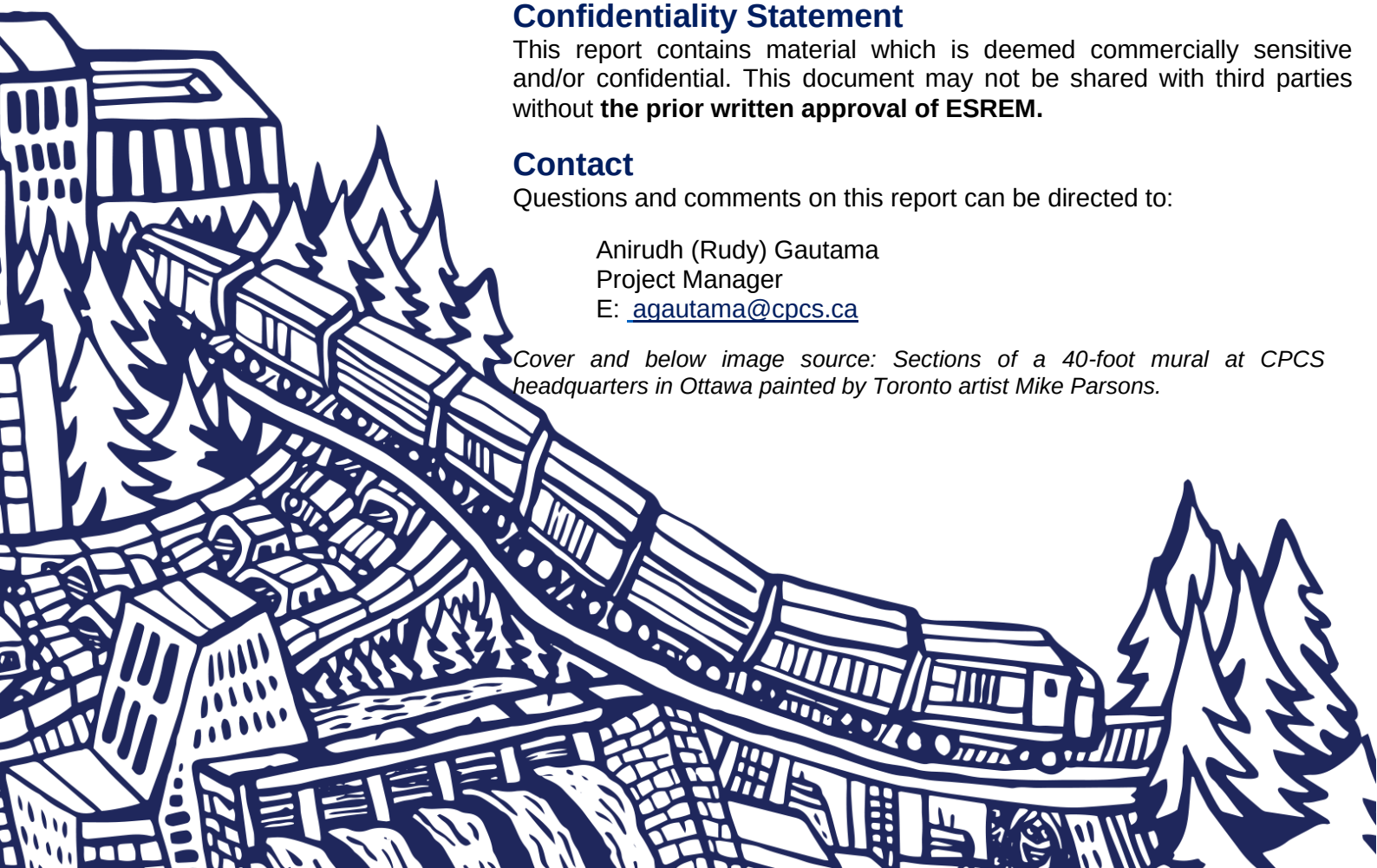


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Acronyms / Abbreviations

Acronym	Definition
AC	Air conditioner
BREEAM	Building Research Establishment Environmental Assessment Method
CFL	Compact fluorescent lamp
COMESA	Common Market for Eastern and Southern Africa
CPCS	CPCS Transcom International Limited
DME	Department of Minerals and Energy
DSM	Demand-side management
EAC	East African Community
ECG	Electricity Company of Ghana
ECOWAS	Economic Community of West African States
EE/RE	Energy efficiency and renewable energy
EEBC	Energy Efficiency Building Code
EEC	Energy Efficiency Centre
EEDSM	Energy Efficiency and Demand-Side Management
EEF	Energy Efficiency Fund
EEPM	Energy Efficiency Planning Model
EES	Energy Efficiency Strategy
EFOT	Financial and Operational Turnaround project
ESCOs	Energy service companies
GETFIT	Global Energy Transfer Feed-in Tariffs
ICF	Inner City Fund
IFC	International Finance Corporation
IOC	Indian Ocean Commission
IPMVP	International Performance Measurement and Verification Protocol
IPP	Independent Power Producer
LED	Light-emitting diode
LEED	Leadership in Energy and Environmental Design
M&V	Monitoring and verification
MDI	Minimum detectable impact
MEPS	Minimum energy performance standards
MSME	Micro, small and medium-sized enterprise
MVE	Measurement, verification and enforcement
NEEA	National Energy Efficiency Agency
NERSA	National Electricity Regulator of South Africa
OTTV	Overall Thermal Transfer Value
RAERESA	Regional Association of Energy Regulators for Eastern and Southern Africa
REFIT	Renewable Energy Feed In tariff
S&L	Standards and labels
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SDG	Sustainable Development Goals
SWH	Solar water heater
TANESCO	Tanzania Electric Supply Company
ToU	Time of use
U4E	United for Efficiency
SOP	Standard Offer Program

1 Introduction

1.1 Authority of the Guidelines

This guideline report is prepared under the authority of the contract signed between the Regional Association of Energy Regulators for Eastern and Southern Africa (RAERESA), an agency of the Common Market for Eastern and Southern Africa (COMESA), and CPCS Transcom International Limited (CPCS), on 11 May 2020, to provide consultancy services “to implement harmonised regulatory/technical frameworks and synthesised renewable and energy efficiency strategies in the EA-SA-IO region.”

1.2 Purpose of this Guidelines

The main purpose of this report is to present a snapshot of existing demand side management (DSM) programs in the targeted regions and formulate guidelines for accelerating the adoption of DSM programs in the EA-SA-IO region. The DSM concept includes areas (MEPS, EE Credit Facility, standards and labelling, etc.) that are presented in further guidelines developed under this mandate.

1.2.1 Demand-side Management: Definition, Objectives, and Measures

DSM can be broadly defined as a set of wide-ranging actions to reduce demand for electricity (or gas) and/or to shift demand from peak to off peak times (International Energy Agency, 2011).

Most DSM measures are adopted by utilities or by the energy end-users themselves— typically industrial enterprises. Utilities encourage energy users to alter their demand profile, and this is generally accomplished through providing incentives for users to reduce overall consumption. In some cases, penalties are charged for the continued operation of inefficient equipment with unnecessarily high loads: this is intended to encourage customers to upgrade equipment and thereby reduce electrical demand.

Industrial enterprises consider a wide range of actions to reduce the consumption of all types of energy. A straightforward reduction in energy consumption will reduce costs, and a shift of demand to a different time might reduce costs if an appropriate tariff is available.

The main types of DSM activities may be classified in three categories:

- Energy reduction programs—reducing demand through more efficient processes, buildings or equipment;
- Load management programs—changing the load pattern and encouraging less demand at peak times and peak rates;
- Load growth and conservation programs.

DSM is a balanced answer to the concept of sustainable development since it helps to ensure rational utilisation and conservation of energy sources (electricity and other electricity generating sources) without hindering collective economic development. It thus contributes to reduce the consumption of natural resources (e.g. gas, petroleum, but also metal, concrete etc.) while reducing the negative externalities (i.e. mainly pollution) of our energy systems.

1.3 Structure of the Guidelines

The remainder of this report is structured as follows:

- Chapter 2 Analysis of Energy Context in the EA-SA-IO member countries and presentation of DSM application in the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS) region.
- Chapter 3 provides an overview of key DSM programs.
- Chapter 4 provides recommendations on developing and implementing DSM programs.

2 Benchmarking Analysis of Energy Context

2.1 Strategies

Based on the results of the data-gathering activity for Work Stream C (see Table 1) and on the research conducted by the Econoler team, it was possible to identify the champions and the countries lagging behind in the development and implementation of DSM measures. Afterward, strategies were identified to support lagging countries in catching up.

2.2 Energy Efficiency Activities in COMESA, EAC, IGAD, IOC and SADC

EE measures are being rolled out in the EA-SA-IO sub regions. Based on an assessment conducted 2020[1], the extent of application of these measures in the EA-SA-IO region is as follows:

- prepayment meters (75% of African countries);
- compact fluorescent lamps (CFLs) or light emitting diodes (LEDs) (69% of African countries);
- awareness raising (53% of African countries);
- power factor correction (29 % of African countries);
- grid loss improvements (28% of African countries).

These measures are largely driven by utilities with limited private sector participation. The intention of most utilities is to meet the power capacity shortages experienced in their countries. Concerted EE Programmes are therefore required for all economic sectors in order for the EA-SA-IO Strategy objectives to be achieved. Stronger legal and regulatory frameworks are required to effectively promote EE. The table below presents some RE and EE Enabling Indicators on policy, strategy and action plans for EA, SA, and IO Region

[1] "Renewable energy and energy efficiency strategy & action plan- Summary Report for Policy Makers", COMESA June 2020.

Table 2-1 RE and EE Enabling Indicators on Policy, Strategy and Action Plans for EA, SA, and IO Region

Member State	Energy Policy	Year	RE Policy Framework			Independent Power Producer (IPP) Policy	EE Policy Framework			Energy / electricity Law	FIT/ Premium Payment	Fiscal Committee		Integrated RE in Rural Electrification
			Policy	Strategy	Master/ Action Plan		Policy	Strategy	Action Plan			Net-Metering Billing	Rebate/Taxes VAT/Exemption	
Botswana	V D	2015	D		V	V				X	V		V	
Burundi	R		D	D	V	V	R			X	V		V	V
Comoros	D	2008	D	D	D	V	D						V	
Djibouti	D		D	V	V	V	V	V	V	X				D
DRC	V					V				X			V	V
Egypt	V		V	V	V	V	V	V	V	X	V	V	V	V
Eritrea	V	2009	V	D	D	V				X				
Eswatini	V	2018			V	V	D			X				
Ethiopia	R	2013	R	R	V	V	R	V	D	X	V		V	V
Kenya	D	2004	D		V	V				X	V	V	V	V
Lesotho	V	2015 -25	V	V	V	V	V	D	D	D	V	V	V	D
Libya				V	V									
Madagascar	V	2015 -30	V	V	V	V			V	X	V		V	D
Malawi	V	2016	V	V		V		V		X	V		V	V
Mauritius	R		D	V	V	V	V	V	V	X		V	V	
Mozambique	V	2011 -15	R	V	V	V				X	V		V	V
Namibia	V	2016	V		V	V				X	V	V	V	V
Rwanda	V	2015	V	V	V	V				X	V		V	V
Seychelles	V	2010 -30	R	R	R	V	D	D	D	V		V	V	
Somalia	V	2010	D							X			V	D
South Africa	V	1998	V		V	V	V	V	V	X	V	V	V	V
South Sudan	V	2007	D	D	D					X				V
Sudan	D		D	V	V	D			D	X				V
Tanzania	V	2015	V	V	V	V	V	V	D	X	V		V	V
Tunisia					V	V	V			X	V	V	V	V
Uganda	V	2007 -17	D		D	V				X	V		V	D
Zambia	V	2008	V	V	V	V		D	D	X	V		V	V
Zimbabwe	V	2012	V		R	V	D	D	D	X	V	V	V	V

V: Approved; X: Absent; D: Under development; R: Under revision

Out of 28 member states, nineteen have approved energy policies that are target-oriented and with commitments on increasing RE sources in the energy mix.

Regarding dedicated RE policies:

- Eleven member states have approved policies with ten of them developing these policies and three revising their policies.
- Twelve member states have RE strategies in place while four are developing their strategies, and revision of these strategies is taking place in two of the EA-SA-IO countries.
- Twenty-four member states have adopted integrating policy frameworks for IPPs, mini-grids and decentralised RE systems and they negotiate power purchase agreements with the private sector.
- Various single and combined fiscal measures in form of rebates, tax credits, VAT and import duty exemptions on solar products and RE equipment have been adopted in twenty-three member states.

EE is driven by laws, policies and market-based instruments such as the ISO 50001 Energy Management Standard because they are interlinked:

- Six member states (Kenya, Malawi, Mozambique, South Africa, Sudan and Zimbabwe) have policies that go beyond the energy sector and support the transport sector through fuel blending mandates using biofuels as import substitution of fossil fuels.
- Egypt adopted voluntary standards for four domestic appliances while South Africa has buildings and environmental management standards and measurement and verifications.
- Sixteen member states have adopted Renewable Energy Feed In tariff (REFIT)[2] and/or Global Energy Transfer Feed-in Tariffs (GET FiT) systems[3]. Island States have embraced Renewable Energy tariff (RETs) because of their vulnerability to climate change, high costs of oil prices, high imports and uncertainty of electricity generation.

2.2.1 Eastern Africa (EA)

EACREEE, in addition to undertaking the Joint Programme on EELA with SACREEE, is involved in the development of standards for refrigeration and air conditioning which will feed into the EELA Project.

The East African region has also undertaken significant initiatives with respect to Energy Efficient lighting and Energy Efficiency in industry. Energy-Efficient Lighting Programs aimed at replacing incandescent light bulbs with compact fluorescent lamps (CFLs) have had significant success in the region:

- Uganda distributed 800,000 CFLs free-of-charge between 2008 and 2010, yielding an estimated USD 100 million in savings.
- Rwanda replaced 800,000 incandescent bulbs with CFLs resulted in an estimated annual power saving of 64 GWh and in a reduction in power demand of 30 MW.

EE efforts are also being carried out in industry. Tanzania's National Energy Audit Programme and Kenya's 2012 Energy Management Regulations require that large-scale energy consumers carry out energy audits every three years. Uganda has a similar programme in place[4].

[2] https://stats.oecd.org/Index.aspx?DataSetCode=RE_FIT

[3] https://www.getfit-uganda.org/

[4] REN 21 EAC, 2018

Uganda's EE Roadmap has prioritised recommendations for implementing EE and cost estimation, and for maximising benefits to meet the goals and priorities established in its 2015 SE4ALL Action Agenda, and an EE Bill is currently with Cabinet to inform the Legal/Regulatory and Institutional and Framework for EE[5]. Kenya has enacted a new law, the Energy Act of 2019, which regulates energy conservation in factories and buildings. Furthermore, the Kenya National Energy Efficiency and Conservation Strategy (NEECS) is a five-year plan (2020-2025) presenting the Kenyan government's ambition for EE, which is one of the country's top priorities. Realizing EE's all-round benefits for the economy, five main sectors are prioritized in the Strategy: residential, buildings, industry and agriculture, transport, and power utilities. The economy-wide target of the NEECS is to "help Kenya reach its international commitments and national targets for cleaner energy and the reduction of greenhouse gas emission as articulated in Kenya's NDCs and in the country's National Action Agenda for Sustainable Energy for All." NEECS plans to achieve an improvement in EE at a rate of 3% per year corresponding to an emission target of 7.6 $MtCO_{2e}$. In addition to this national target, specific objectives and actions were defined for each priority sector with indicators.

Between 2012 and 2014, an estimated 5.3 million clean cook stoves were distributed in the region. In addition, Kenya, Rwanda and Uganda have adopted initiatives on improving the efficiency of charcoal production.

2.2.2 Indian Ocean (IO)

The IO member states are implementing the Renewable Energy Development and Energy Efficiency Improvements project (2014 to 2019). Furthermore, Standards and Labels have been developed in most member states for all categories of buildings and for household appliances and equipment with major impact on electricity consumption and peak load[6].

Seychelles has implemented the 'Energy Act 2012' and also the 'Electricity Master Plan 2019', the latter focuses on a roadmap for RE to 2030.

2.2.3 Southern Africa (SA)

SACREEE has been given the mandate to implement the SADC Renewable Energy Efficiency Policy Southern Africa Program (REEEPSAP) which focuses on identified demand side and EE portfolio of projects; awareness raising, including implementation of energy efficiency labels and MEPS; energy-efficient lighting, industrial equipment and cooking technologies; fuel switching; load management (time-of-use tariffs); electricity grid loss mitigation (pre-paid and smart metering); EE Building Codes [7].

To achieve these deliverables, SACREEE has started implementing three projects, namely:

- SADC Industrial Energy Efficiency Programme (SIEEP) to support the implementation of the SADC Industrialisation Strategy and Roadmap (2015-2063) by enhancing the competitiveness of the industrial sectors of the SADC member states[8].
- The Cooking Stove Programme to improve energy access including clean cooking devices.
- EE Lighting and Appliances (EELA) project in Eastern and Southern Africa supported by the Swedish International Development Corporation SIDA in-conjunction with EACREEE to develop MEPS, appliance labelling, mapping and building up capacity in regional test laboratories[9].

[5] EE Roadmap 2015
[6] IOC Project document
[7] SACREEE Market based opportunities of RE and EE, Paper presented at Zoning workshop, 2017
[8] REN 21 ,2018
[9] Clasp Feb 2019. Overview of the On-grid and Off-grid markets in Eastern and Southern Africa, Final Report at: www.Clasp.Ngo

In the region, South Africa represents the country that mostly progressed in developing and implementing EE policies and initiatives. The table below resumes the recent policies adopted.

Table 2-2: Energy efficiency policies

Name	Policy Description (Goals)
Carbon Tax 2019	Carbon Tax Act No 15 of 2019 gives effect to the polluter-pays principle for large emitters and helps to ensure that firms and consumers mitigate their negative adverse costs (externalities)
Draft Post NEES[10] 2015	› The post-2015 NEES aims to build on the achievements of theoriginal NEES 2005 › Improving household EE (reducing residential energy demand) › Providing support to the Appliance & Equipment Efficiency Standards & Labelling Program
NDP 2030 2012	› Transition to a low-carbon economy: reducing carbon emissions to the baselines of 34% in 2020 and 42% by 2025.
NEES 2005	› Aimed to reduce the nation's energy intensity and decouple economic growth from energy demand › The strategy is divided into 4 sector programs: Industry and Mining; Commercial and Public Buildings; Residential; and Transport. › Target of 12% reduction in overall primary energy consumption by 2015.

2.3 Demand Side Management Measures in EAC, IOC, and SADC

Most countries in EAC, IOC, and SADC regions do not have laboratory testing facilities for MEPS equipment, except South Africa. Mauritius has recently introduced laboratory testing for refrigerators, dishwashers, and electric ovens, and plans to cover air conditioners and washing machines in January 2020, through EU funding to IOC.

2.3.1 EAC

Kenya is implementing MEPS through the Appliances Energy Performance and Labelling (Amendment) Regulations of 2018, which established MEPS and labelling requirements for several appliances, including self-ballasted lamps; double capped fluorescent lamps; ballasts for fluorescent lamps; refrigerating appliances; non-ducted air conditioners; and three-phase squirrel cage induction motors. The Draft Energy Efficiency and Conservation Bill[11] in Uganda is still in process and has been submitted to the First Parliamentary Council for drafting. The Bill seeks to provide for: the legal, regulatory and institutional framework for EE, and the establishment of MEPS for equipment such as refrigerators, air conditioners, motors and lighting.

2.3.2 IOC

Seychelles and Mauritius have adopted regulations for MEPS. The Solar Water Heater Endorsement Initiative has established standards. There is on-going energy audit training for the Public Sector under the EE Programme. Mauritius has mandatory EE labelling for appliances37 such as refrigerators, dishwashers and electric ovens. It applies a 25% levy on these appliances that have an EE index below set thresholds.

2.3.3 SADC

In SADC, SAPP has collaborated with power utilities, through an EE Framework, to reduce electricity consumption and demand especially, during peak periods. The EE Framework

[10] The post-2015 NEES is still in draft stage, the reader may consider the draft status wherever mentioned.
[11] Draft Energy Efficiency and Conservation Bill

consists of implementing Demand Side Measures and initiatives such as promotion of CFLs, LED Lamps, hot water load control, solar water heating and commercial lighting. Other realised savings were from industrial and mining activities. In 2017, SAPP reported a cumulative energy savings of 4,031 MW, compared to an installed operating capacity of 54,397 MW[12].

Only South Africa is setting up legally binding MEPS. For South Africa, this is through the programme entitled 'Market Transformation through Energy Efficiency Standards and Labelling of Appliances in South Africa'.

The Government of the Republic of Zambia issued a Statutory Instrument (SI) No.74 of 201634, in line with the Control of Goods Act, to phase out incandescent bulbs by banning the manufacturing and importation of the products and was expected to realise additional energy savings of about 200 MW. Zimbabwe also banned incandescent bulbs on 1 May 2017 under Statutory Instrument 21 of 2017[13], and the country was expected to save 300 MW of electricity through use of more efficient Light Emitting Diode bulbs.

2.4 DSM Application in SADC

SADC member states have largely implemented DSM measures. Here best practices in the region are presented as references for all for COMESA, EAC, IGAD, IOC, and SADC member states.

In the SADC region, several national utilities – NamPower, SNEL, TANESCO, ZESA and ZESCO – have developed DSM programs on their own based on the Southern African Power Pool (SAPP) initiative, although theirs are more extensive.

NamPower in Namibia is distributing one million free LED bulbs and subsidising 20,000 solar water heaters (SWHs) as part of its DSM campaign. Two countries – Mauritius and South Africa – have developed full national energy efficiency programs with appropriate policy initiatives to support them[14].

In 2010, South Africa also implemented the Energy Efficiency and Demand-Side Management (EEDSM) program through the national utility, Eskom, with offerings in the commercial, industrial and mining sectors. The EEDSM program includes incentives and rebates to encourage the uptake of efficiency in various economic sectors, including residential, and is supported by other government policy initiatives, including a proposed carbon tax and mandatory development and monitoring of energy management plans for industry.

Table 2 below outlines major energy efficiency and DSM activities in SADC member states. The most common initiative is replacing incandescent light bulbs with CFLs, which has occurred in 13 of the 15 countries. The least common initiative is demand market participation, which requires strong technical collaboration between utilities and their main customers.

[12] REN 21 SADC, 2018

[13] Government of Zimbabwe, 1May 2017 under Statutory Instrument 21 of 2017

[14] REN21, « SADC renewable energy and energy efficiency status report », 2015.

Table 2-3: Energy Efficiency and Demand-Side Management (DSM) Activities in SADC Member States and Utilities[15]

	CFL exchange	Energy-saving awareness	Demand market participation	Time-of-use tariff	Hot water load control	Solar water heating	EE in buildings	EE audits	Prepaid meters	General rehabilitation	Transmission line upgrade	Power factor correction	Distribution loss reduction	Standards and product labelling
Angola	X													
Botswana	X					X	X							
DRC	X													
Lesotho	X													
Madagascar														
Malawi	X													
Mauritius	X	X				X			X				X	X
Mozambique	X													
Namibia	X	X	X	X	X	X	X	X		X		X		X
Seychelles	*V (LED)*	*V*					*V*	*V*						
South Africa	X	X	X	X	X	X	X	X	X					X
Swaziland	X			X						X		X		
Tanzania	X	X		X						X	X	X	X	X
Zambia	X	X		X		X		X	X	X	X	X	X	X
Zimbabwe	X	X		X	X		X	X	X	X	X	X	X	

[15] REN21, « SADC renewable energy and energy efficiency status Guidelines", 2015.

2.4.1 South Africa (SA)

In 2004, the National Electricity Regulator of South Africa (NERSA) promulgated the Regulatory Policy on Energy Efficiency and Demand-Side Management for the South African electricity industry. This policy included:

- Defining the roles, responsibilities, and obligations of major electricity distributors for EE/DSM, alongside the related licence requirements.
- Defining the potential roles of energy service companies (ESCOs).
- Establishing an independent monitoring and verification (M&V) body, accountable to NERSA, to conduct all of the M&V functions.
- Establishing EE/DSM fund administered by Eskom[16] (the Eskom EE/DSM Fund) and the rules and procedures defined for fund implementation.

Eskom was required to:

- Implement EE/DSM as a condition for the approval of Eskom tariff/price increase in accordance with the EE/DSM regulatory policy.
- Submit an EE/DSM rollout plan to the NERSA.
- Establish the EE/DSM Fund and recover the direct EE/DSM costs from the tariffs of all customers in the manner specified by the NERSA.
- Evaluate and approve EE/DSM projects submitted by ESCOs.

The NERSA set a licence condition on the major distributors to develop an EE/DSM Plan and implementation schedule as well as submit these to the NERSA for approval. Major distributors screen EE/DSM project proposals from ESCOs and customers. The NERSA approves the benchmark criteria for the approval of EE/DSM projects by Eskom and for screening project proposals submitted by major distributors.

To accelerate progress in ESCOs implementing EE/DSM, Eskom, NERSA, the National Energy Efficiency Agency (NEEA) and the Department of Minerals and Energy (DME) launched a standard offer program (SOP).

The SOP[17] is a mechanism for acquiring demand-side resources (EE and load management) under which a utility (or a government agency) purchases energy savings and/or demand reductions using a predetermined and pre-published rate in cents per kWh or Rand per kW based on verified savings. Any energy user (utility customer) or ESCO that can deliver energy and/or demand savings is paid the fixed amounts per kWh or kW (the standard offer amounts) upon completion of EE/DSM projects and certification of the achieved savings by an authorised M&V organisation.

The SOP applies to the following EE projects:

- Government-owned buildings (particularly hospitals and clinics, prisons, military barracks, offices, etc.) and private residential dwellings.

[16] Eskom is SA's public utility. It supplies 95% of the country's electricity and more than 40% of the electricity used in Africa. It has 3,000 industrial customers, 1,000 mining customers, 50,000 commercial customers, 84,000 agricultural customers and millions of residential customers. Its generation capacity is 91% dependent on coal and, because of Eskom's hold on the SA electricity supply, coal accounts for 85% of all SA's electricity supply. The difference is made up by municipalities, imports and, more recently, IPPs.

[17] Practice implemented in Australia, India, the U.S., etc.

- Commercial buildings including offices, hotels and other hospitality facilities, employee compounds at mines, refineries and power stations, etc.
- Existing housing developments.
- Solar water heating projects.
- Energy conservation in the industrial sector.

A methodology for M&V was developed by Eskom and approved by NERSA.

The M&V approach utilises the guidelines provided by the International Performance Measurement and Verification Protocol (IPMVP)[18].

The M&V methodology will be published as part of the SOP description. Eskom also prepared and published a list of organisations pre-approved to conduct M&V for projects being proposed under the SOP. Currently, the M&V for EE/DSM projects is carried out in South Africa by a number of university-based groups[19].

According to Eskom, the success achieved by this program resulted in average demand savings of 600 MW between 2005 and 2013[20].

2.4.2 Tanzania

In 2013-2014, USAID EECDP conducted a work stream project in Tanzania to improve integrated demand-side resource planning for the energy sector. The work stream focused on developing DSM programs to reduce current and future consumer energy demands. Achievable DSM potential was estimated, and the results were used to develop seven program recommendations and implementation guidelines. With all programs implemented, Tanzania could cost effectively reduce system peak demand by 11.5 percent after five years.

The first activity to develop the DSM programs was to conduct an analysis of demand-side energy use and develop load profiles. Several analyses were carried out:

- Literature review of the Tanzanian power sector, including data from the main power supplier, Tanzania Electric Supply Company (TANESCO), related to operations, business and cost structure, customer base, load, and technical challenges.
- Analysis of TANESCO electric meter, demand factor, and power factor data from smart meters on around 16,000 industrial and commercial rate customers, site audit data for the development of hourly and end-use profiles of each building or facility.
- Energy load profiles for residential, commercial, and industrial customers, notably aggregate end-use load profiles for each customer segment.

The second activity was to create a DSM measure database and determine the achievable potential of DSM measures. This activity included:

- Development of a database of DSM measures covering major end uses within the residential, commercial, and industrial customer segments; DSM potential estimated using energy and demand savings combined with measured lifetime and costs.
- Establishing of the technical and economic potential of DSM measures by using ICF's[21] Energy Efficiency Planning Model (EEPM).

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[18] Efficiency Valuation Organisation, International Performance Measurement and Verification Protocol, http://www.evo-world.org/.

[19] EEDSM, M&V in South Africa, 2012,

[20] https://eta.lbl.gov/sites/default/files/seminars/eedsm_mv_in_rsa_berkeley.pdf. Energy Efficiency Country Study: Republic of South Africa, Berkley Lab, 2013, https://www.osti.gov/servlets/purl/1165577.

[21] https://www.icf.com/

- Definition of the achievable potential of DSM measures considering financial barriers, lack of awareness, and market barriers.

Finally, the work stream project concluded with the development of the DSM implementation plan guidelines and recommendations. The DSM measures were evaluated by considering six indicators:

- Energy and capacity savings.
- Market transformation rate.
- Equity across customer classes.
- Political feasibility.
- Cost effectiveness.
- Risk mitigation potential.

Based on this evaluation, seven program options were recommended with guidelines to provide a basic structure for each option and included load and cost forecasts. The program options were:

- Residential Refrigerator Recycling and Replacement program to remove and recycle old residential refrigerators and replace them with energy efficient units.
- Residential Lighting program to provide customers with compact fluorescent light bulbs (CFLs) through giveaways.
- Energy Solutions for Commercial Customers program to offer financial incentives and technical assistance to commercial customers to improve their energy efficiency.
- Commercial Refrigerated Vending program to work with beverage companies to increase the use of efficient refrigerated beverage vending machines.
- Commercial Direct Load Control program to enable TANESCO to cycle off participating commercial customers' air conditioners (ACs) during peak demand periods.
- Energy Solutions for Industrial Customers program to offer financial incentives and technical assistance to industrial customers to improve their energy efficiency.
- Industrial Time-of-Use Tariff program to motivate facility owners and managers to shift electricity use from periods of highest demand on the grid to periods of lower demand.

The portfolio of projects was expected to save a total of 142 GWh and 153 MW, equal to 2.1% of forecasted load and 11.5% of peak demand respectively.

2.5 DSM Application in the Economic Community of West African States (ECOWAS)

A couple of good practices for DSM application have been identified in member states of West Africa. Here such practices are presented as references for the EAC, IOC, and SADC member states.

In the Economic Community of West African States (ECOWAS) region, two countries have adopted DSM activities, namely Ghana and Nigeria, but DSM programs still remain undeveloped.

Ghana and Nigeria have already implemented a few measures:

- Ghana: CFL exchange, energy-saving awareness, product standards and labelling.

- Nigeria: CFL exchange, energy-saving awareness, EE in buildings, product standards and labelling.

The other ECOWAS members have developed national strategies and awareness initiatives and several barriers have been identified in implementing DSM programs:

- Lack of adequate energy policies.
- Lack of institutional capacity.
- Lack of adequate data and information.
- Lack of independent regulatory bodies for energy sectors.
- Lack of finance.
- Lack of knowledge and skills.
- Absence of a large sustainable energy market due to the high-risk environment for private investors.

2.5.1 Ghana

The Ghana II Compact, launched in 2016, comprised four projects designed to address critical challenges faced by the electricity sector[22]:

- The Electricity Company of Ghana (ECG) Financial and Operational Turnaround (EFOT) project to improve ECG management and efficiency by introducing private-sector participation, reducing outages as well as commercial and technical losses, and modernising the electricity distribution system.
- The Regulatory Strengthening and Capacity Building Project to promote sustainability, transparency, and accountability in the power sector by strengthening regulatory institutions and processes, reviewing and restructuring tariffs, and improving the environment for private sector investment.
- The Access Project targeting micro, small, and medium-sized enterprises (MSMEs) in markets and economic enclaves in urban and peri-urban areas, with activities to increase legal connections and improve security lighting.
- The EEDSM Project to improve building and appliance efficiency and reduce energy wastage through energy audits, standards and labels for energy efficient devices, upgrades to street lighting, and education and public information activities.

The EEDSM project seeks improve building and appliance efficiency and reduce energy wastage through the introduction of standards and labels, energy audits, and outreach activities. The main measures are:

- Development and Enforcement of Standards and Labels activity: for machinery and household electrical appliances and motors, test facility construction, and field metering and monitoring studies.
- Improved Energy Auditing activity: energy audits and retrofits in a small set of government buildings and setting up two Sustainable Energy Service Auditing Centers to train auditors.
- Education and Public Information activity: pilot of energy efficiency school curriculum updates for 30 pre-tertiary schools and direct public education prior to enforcement of standards and labels.
- Demand Side Management activity: installing energy-efficient LED streetlights in the ECG Accra East and West operational regions.

[22] Ghana - Energy Efficiency and Demand-Side Management, 2019 Evaluation Catalog (mcc.gov).

The EEDSM Project will provide benefits to households in electrical service areas over a 20-year horizon by increasing the purchases of energy efficient appliances through the establishment of energy efficiency standards, which will reduce the growth of peak electricity demand.

In 2019, Mathematica Policy Research published the Evaluation Design Report on the Ghana II Compact. The evaluation has three rounds of data collection, a 2019 baseline, a qualitative midline in 2021 near the end of the Compact, and an endline by 2023. To estimate the impacts of the EEDSM Project, the minimum detectable impacts (MDIs) will be calculated as a fraction of the mean of the outcome, assuming a simple shift in the mean outcome after the intervention is implemented[23].

2.5.2 Nigeria

The Nigerian Electricity Regulatory Commission has regulatory leadership on DSM matters and thus far developed two main programs in 2016:

- Using CFLs to decrease peak loads by up to 60%.
- Rolling out electricity meters and smart meters for future DSM programs (metering level is about 50% of the customer population).

In 2015, a national GEF project in Nigeria ended, which was part of the Strategic Program on Energy in West Africa led by UNDP. The project included:

- Standards and labels (S&L) and DSM.
- Energy labels and minimum energy performance standards (MEPS) for new equipment.

A total of one million CFLs were distributed in residential and public buildings throughout the country by the Energy Commission of Nigeria, leading to peak electricity reductions of 38 MW. A National Energy Efficiency Policy was developed, including a road map for integrating energy efficiency into national programs. Furthermore, an awareness campaign was launched, and the capacity of the relevant stakeholders is being enhanced to meet the objectives of the project.

More energy efficiency measures to implement the DSM program will be carried out in the next years.

[23] Ghana Power Compact: Evaluation Design Report, 2019.

3 Key DSM Programs

3.1 Introduction

Electric utility DSM programs consist of planning, implementing, and monitoring activities that are designed to encourage consumers to modify their level and pattern of electricity usage.

DSM programs are mostly developed in national contexts by countries that have adopted specific regulations such as energy conservation acts.

Energy conservation act

An energy conservation act seeks to establish a comprehensive law that adopts standards and procedures and prescribes measures for energy conservation.

Energy conservation acts should require large energy consumers to adhere to energy consumption norms, new buildings to be built in accordance with building codes, and appliances to meet energy performance standards and to display energy consumption labels. Furthermore, such acts need to organise policies and programs on the effective utilisation of energy with stakeholders to establish frameworks and strategies to verify measures and monitor energy efficiency improvements in the private and public sectors.

3.2 DSM Measures

Most DSM measures are put in place by utilities or by the energy end users themselves—typically industrial enterprises. Utilities try to encourage energy users to alter their demand profile, and this is generally accomplished through positive tariff incentives allowing customers to schedule demand activities at a time that will reduce their energy costs.

The main types of DSM activities may be classified in three categories:

- **Energy reduction programs** – Reducing demand through more efficient processes, buildings or equipment; improving performance of boilers, steam systems, etc.; efficient lighting; appliance labelling; building regulations; efficient use of electric motors; preventative maintenance; energy management (energy purchasing, metering and billing, performance measurement, energy policy development, energy surveying and auditing, awareness raising, training and education, capital investment management); energy auditing.
- **Load management programs** – Changing the load pattern and encouraging less demand at peak times and peak rates; load levelling (peak clipping, valley filling, load shifting, load control); tariff incentives or penalties (time-of-use and real-time pricing, power factor penalties, load growth and conservation programs).
- **Load growth and conservation programs** – Growth by switching energy sources (fuel) to more efficient electrical sources; growth strengthens utilities' capability to manage loads; conservation results in a reduction in sales as well as a change in patterns of use.

Key measures are presented in the following subsections.

3.2.1 Standards and Labelling

Further details are provided in the MEPS guidelines prepared as part of the ESREM project.

Electrical appliances

Standards and regulations (MEPS)

Standards and regulations (i.e. MEPS) cover a collection of related requirements defining which products can be sold and those that should be banned from the market. Standards and regulations form the foundation to ensure the success of any efficient appliance transition strategy.

Based on the recommendations of the United for Efficiency (U4E) initiative[24], preparing MEPS for efficient appliances requires the following:

- Establish a legal framework: Review existing legislation and establish framework legislation to develop a legal basis for and political commitment to mandatory efficiency standards and energy labels.
- Appoint an administrative agency: Assess existing institutional capacity for developing, implementing, and maintaining a standards and labelling program. Develop an overall standards and labelling plan and assign one government agency with the primary responsibility of driving each element of the program.
- Assemble a stakeholder group: Identify the key relevant people in the economy who would be interested and invite them to participate in the process.
- Gather required data: Establish minimum data needs and develop a plan for collecting the data necessary to conduct analyses to support the program. This includes information on the market, technology, engineering, and usage of products.
- Conduct an economic analysis: Use cost-effectiveness analysis to determine the appropriate level of ambition for the regulatory measure(s).
- Harmonise testing: To the greatest extent possible, harmonise energy performance test procedures with international protocols (such as International Electrotechnical Commission test standards) to facilitate testing and reduce barriers to trade.
- Set MEPS levels: Determine the technically feasible, economically optimal regulatory level; invite stakeholders to comment and refine MEPS if necessary; secure political endorsements; publish regulatory notices; and specify a date when MEPS will take effect.
- Review and update: Plan to periodically review and update the MEPS every few years to ensure they remain appropriate and relevant.

Labelling

Domestic appliances represent an important source of energy consumption in households, especially refrigerators and water heaters. Appliance labelling allows consumers to compare appliances from various manufacturers and make informed judgments when buying new appliances. Generally, labels contain a simple means of rating consumption, for example a letter from A to G (where A is the most efficient). Labels may also contain the consumption levels of appliances in kWh per year or be expressed as an estimated cost of operating the appliance for one year, for example.

Energy labelling needs to be in place for at least a couple of years before effects can be observed on consumption levels to allow consumers to become familiar with the content of a label and then make a choice.

[24] https://united4efficiency.org/resources/publications/?fwp_integrated_policy_approach=standards-and-regulations.

Energy and environmental performance labelling for buildings

As the significance of sustainable development and the green building industry has been growing worldwide over the last few decades, many rating systems for assessing the environmental impacts of buildings have been developed in several regions. All rating systems are generally aimed at promoting an integrated sustainable building process and individual practices. However, each system has its own categories, scoring system, weighting system, and outputs as major components. These schemes are designed to render projects more sustainable and environmentally friendly by providing frameworks with a set of criteria that cover various aspects of a building's environmental impacts. Examples of rating systems include:

- Edge from the International Finance Corporation (IFC).
- Leadership in Energy and Environmental Design (LEED).
- Overall Thermal Transfer Value (OTTV).
- Other systems:
  - Estidama Pearl Rating System.
  - Building Research Establishment Environmental Assessment Method (BREEAM).

Most such systems use rating points to evaluate the energy performance of buildings. However, countries lacking national rating systems and related labelling could develop their own by adopting the following steps:

- Draft label designs and identify EE rating categories.
- Propose the draft designs to stakeholders and update them based on their feedback.
- Draft regulations requiring labels.
- Obtain government approval of both regulations and labels.
- Prepare implementation and enforcement plans.
- Prepare tools for certified energy rating auditors.
- Prepare training material and deliver training to market players and government authorities.
- Develop communication and awareness-raising plans and execute communication and awareness activities.
- Develop a database of labelled buildings.
- Develop and implement monitoring and evaluation schemes.

3.2.2 EE Building Codes (EEBCs)

The design and construction of buildings are regulated in most countries by EE building codes that set minimum standards for various items that impact both the energy consumed to operate buildings and items affecting safety.

The details contained in regulations can be quite comprehensive and designed to require architects, designers, and contractors to adopt good energy efficiency practices and thus reduce the energy consumed in the built environment including residential, commercial, and industrial buildings. Typically, regulations cover:

- Improved building construction materials to reduce heat losses through walls and floors.
- Insulation of roof spaces to reduce heat losses.
- Window design and construction to minimise heat losses/gains.
- Standards for the performance and control of air-conditioning systems.
- Efficiency standards for lighting and use of natural lighting.

- Minimum efficiency standards for central heating boilers and hot water heaters.
- Smart controls (timers and temperature).
- Application of solar water heaters and passive space heating.
- Installation of RE equipment.

To ensure the successful application of codes, the implementation schedule should be divided into a number of phases to gradually apply the code to various kinds of building components. This schedule should specify not only effective dates, but also the types of private-sector or public-sector building projects to which a given code applies.

The code authority should establish an energy efficiency building code (EEBC) management committee charged with periodically reviewing monitoring and evaluation data that provide indicators on effectiveness and process efficiency. International best practice demonstrates that a five-year management cycle is usually sufficient for an established EEBC.

3.2.3 Energy Audits

Energy audits should be implemented in sectors/industries identified as energy intensive and by establishing regulations for energy audits conducted by accredited auditors.

When setting up an energy management program, it is necessary for organisations to undertake a complete review of energy consumption and corresponding activities, e.g. quantities manufactured, buildings heated or cooled. An energy audit is conducted to gather all the relevant data and analyse performance throughout the given organisation, through which deficiencies can be identified and improvement recommendations issued.

Audits may be applied, for example, to industrial operations, commercial buildings, transport companies, and domestic premises. A typical audit for an industrial company might consist of carrying out some or all of the following steps:

- Obtain information on the processes employed, plant equipment and physical facilities, design data, as well as machinery characteristics and production capacities.
- Determine from historical records the emissions, energy consumption and production levels for a given plant and key departments (over a period of two to three years for example).
- Determine, if necessary, from onsite measurements using portable instruments, the actual operating parameters and performance of equipment and processes.
- Observe the nature and extent of energy management procedures and reporting and the corresponding management structure in the organisation.
- Analyse the data obtained and the observations made to establish the energy utilisation efficiency of key equipment.
- Identify and characterise the constraints to improving performance, including organisational, technical, and financial constraints.
- Identify potential improvement measures and carry out financial evaluations on the investments needed.
- Develop a logical action plan to address constraints, including specific recommendations and priorities for the different measures.

3.2.4 Measurement, Verification and Enforcement (MVE) Framework

A MVE framework should be developed to include an assessment of the current scheme for goods imported into selected countries, as well as international and regional best practices. This analysis will help to identify an MVE framework suitable for each country market that can support the implementation of regulations, standards and DSM programs.

One key element to support the MVE framework is a product registration database for targeted equipment. Such a tool can help quickly and inexpensively identify and track products on the market to verify which have satisfied program requirements.

Figure 3-1 MVE process



Completing the MVE framework is the market monitoring and evaluation process. The active market monitoring and product sampling to identify non-compliant products, as well as appropriate actions are needed to maintain program integrity. In addition, the tracking of qualified products importation and sales, as well as their performance levels, other relevant indicators, and market shares over time is needed in order to evaluate and maximise implementation effectiveness as well as to determine energy and emissions saving impacts.

Furthermore, it is highly recommended to refer to the International Organization for Standardization (ISO) 9001[25] for the quality management principles and the ISO 50001[26] to improve energy use, through the development of an energy management system (EnMS) as well as the ISO 14000[27] to establish, implement, maintain and improve an environmental management system (EMS).

3.2.5 Promotional Activities

Promotional activities include awareness campaigns, education and training, as well as fiscal and financial incentives (including energy pricing).

Awareness

Access to information is a fundamental component for developing a sustainable environment to implement EE. Lack of information may impede an energy end user from undertaking EE activities and, unfortunately, it is one of the major barriers encountered in most countries. It is recommended that an EE awareness and information plan be developed, for the general public, specific targeted groups, and sectors, to stimulate greater interest in EE.

Training

Skilled managers and staff will be required to plan, develop, implement, measure, and verify DSM programs. Successful demand and energy management initiatives around the world have always been implemented with comprehensive and well-thought-out capacity building activities.

Ideally, training programs consist of a blend of lectures, case studies, seminars, international twinning, and customised hands-on activities. Special training programs could be considered for special activities such as ESCO development and financial institution involvement in EE efforts.

[25] https://www.iso.org/publication/PUB100080.html.
[26] https://www.iso.org/iso-50001-energy-management.html.
[27] https://www.iso.org/standard/72333.html.

Energy prices and tariffs

One of the main elements in the development of a sustainable EE market is the use of market-based energy prices instead of subsidised prices. Indeed, increased energy costs will directly improve the return on investment of EE projects, thus making them a lot more attractive to end users and promoters. Since EE markets have been identified as very sensitive to price increases, such increases will become one of the key drivers of the EE market development and sustainability, on top of other benefits related to an unsubsidised price structure for the country. When energy prices reflect the cost of supply and consumers can directly respond to price signals, significant behavioural changes occur.

In addition, a time-of-use (ToU) tariff scheme could be introduced in phases in the industrial sector. It is also beneficial to investigate the possibility of introducing a ToU tariff in the residential sector to help not only reduce the peak load, but also reduce energy consumption due to behaviour changes.

4 Recommendations

A DSM program development process requires several steps as defined in the figure below[28].

Figure 4-1 Demand-side management planning procedures



4.1 Program Planning

DSM program planning is the cornerstone on which the development of any energy efficiency policy rests. It is at this stage that the right program is chosen, analysed, and action towards its implementation can be prioritised. Key- activities are listed below.

4.1.1 Institutional Environment

To meet the objectives of the DSM program, it is essential that an effective institutional structure be established. The following questions must be properly answered while analysing the planning process.

- Who will be directly responsible for DSM activities?

[28] "Demand-side management from a sustainable development perspective", TERI, Econoler, IREDA, Agence de l'Efficacité Energétique Québec, 2003.

- What kind of performance indicators will be used?
- What motivational factors and incentives are required to change the conventional management patterns of a company?
- What additional organisational changes, training programs or resources are required for the new services?

Establishing an EE centre (EEC)

The first step often undertaken by countries with a low level of EE programs and activities is the establishment of a donor funded energy efficiency centre (EEC). These centres are typically non-profits and supported by governments. They have independent authority to conduct research and analysis, raise awareness, and recommend energy policies. Furthermore, they are mandated to design and implement EE programs and play a central role in fostering market transformation through which the implementation of energy efficient products and services becomes standard practice. They provide a focal point for EE activities and have high credibility due to their non-profit status. An EEC with adequate independence and funding can review and evaluate existing EE efforts and ensure their proper implementation. EECs can play the role of advocating proper implementation of energy labelling and MEPS, EE provisions for building code legal requirements, as well as presenting a blueprint for how to meet legal requirements.

By providing assistance in the design and implementation of EE policies and programs, an EEC helps strengthen the institutional capability of government institutions to carry out EE initiatives. Over time, EEC staff can even take management positions at government institutions, thereby transferring EE management capacity directly to those institutions.

A DSM unit within the EEC should be created to ensure analysis, program development, as well as management and implementation of end-use EE programs.

The DSM unit should start out reporting directly to the chief executive of the utility to ensure that the concept of EE is given attention at the highest level and is not subjugated and “controlled” by lower-level managers who may not support the EE/DSM mission.

4.1.2 Establishing Load-curve Modification Objectives

The first component in the planning process is to establish clear and measurable objectives for load-curve modification. The desired type of load-curve modification will determine the type of program that will be retained. That can be done through load management. The types of load management techniques are:

- Load levelling helps to optimise the current generating baseload without the need for reserve capacity to meet the periods of high demand.
- Load control is where loads (e.g., heating, cooling, ventilation and lighting) can be switched on or off, often remotely, by the utility.
- Utilities encourage a certain pattern of use by tariff incentives where customers use energy at certain times to achieve a better-priced rate for their energy use. (Time-of-use rates—where utilities have different charges for power use during different periods; Higher peak time charges would encourage a user to run high load activities in an off-peak period when rates are lower; Power factor charges, where users are penalised for having power factors below a fixed threshold, usually 0.90 or 0.95; Real-time pricing, where the rate varies based on the utilities load (continuously or by the hour)).

The objectives will enable to incorporate the DSM measures into the specific electricity needs of the target users.

4.1.3 Market Research

Once the objectives are clearly defined, the planner must examine the various components of the electricity network including such issues as production, transportation, distribution, and the end-use of energy in order to recognise any problem faced at each step of the process and the reasons for the load-curve's current performance. The planning process must also include an analysis of consumption and demand forecasts to develop top-down models that usually rely on historic values of aggregate consumption and macroeconomic variables. Such forecasts often only need a few and easily available input variables and bottom-up models for aggregate electricity demand, typically modelling energy consumption of individual service or end-use appliances/equipment and then aggregating consumption over the entire stock. That will allow to appraise baseload electricity consumption patterns and growth forecasts for the country as a whole and for key sectors – residential, commercial, government/institutional, and industrial. This will help to identify the main consumers within the key sectors, define the energy demand drivers, and target EE measures that will provide long-term energy savings and have an impact on peak loads. The consumption profiles should be based on meter data and other customer information that may be available from

4.1.4 Evaluation and Selection of Measures

Based on market research findings, the planner can determine the best way to adapt supply and demand by combining production increases with DSM programs. All this should be in harmony according to load-curve modification objectives, which will help to adjust the production capacity to an optimal demand profile. After the preliminary analysis, the planner intuitively determines the measures that could eventually be incorporated into the DSM programs.

4.1.5 Developing an Energy Efficiency Strategy (EES)

The EES is a pillar for the development and implementation of EE specific legislation and programs. It constitutes the roadmap for sustainable energy efficiency market development and implementation and supply guidance to parliamentarians, who will eventually be called upon to endorse certain elements through appropriate legislation, as well as to all relevant actors having a role in promoting energy efficiency, including the energy industry, the energy service sector, academics and researchers, energy users, other levels of government, potential investors, and international and bilateral organisations.

A key success factor for developing and implementing the EES is to promote cooperation among the many stakeholders involved by addressing conflicts and building on synergies. A crucial aspect is leadership from high-level actors, including government and planning agencies. Countries that have successfully undertaken EES often demonstrate long-term commitments by acknowledging the benefits of EE in their energy planning and policies[29].

4.1.6 Identifying DSM Programs

At this stage in the planning process, collected information is normally useful in determining a typical load curve for each end use. This curve provides proper understanding of both the modulations for each type of end use and the time at which peak consumption periods occur. By superposing each of these typical load curves according to end use, the overall load curve is established and explained. Analysing how electrical power is used then serves to identify the services for which activities should be launched to meet load-curve management objectives through DSM programs. Such activities should be selected after being ranked not only according to the amount of energy they could save, but also on the basis of their respective impact on

[29] Kenya National Energy Efficiency and Conservation Strategy, 2020. https://unepdtu.org/wp-content/uploads/2020/09/kenya-national-energy-efficiency-and-conservation-strategy-2020-1.pdf

evening peak demand, their relative ease of implementation, and the number of stakeholders involved.

To identify and select measure it could be helpful to develop Excel spreadsheets designed as a market demand-side management analysis tool that can be used to rapidly develop scenarios of EE potential and cost effectiveness.

The tool should be adapted based on the level of detail that will be made available from the data-collection task to develop the EE potential and cost effectiveness of various proposed measures (including financial indicators such as payback periods). The Excel tool should include the following features:

- Table for the projected increase in energy and demand (electricity) based on historical trends;
- Tables for the disaggregation of:
  - energy usage by market;
  - different end users in a market segment (lighting, motors, ventilation, ACs, etc.);
- Tables for the calculation of:
  - potential impacts on the load curve, peak electricity demand, overall electricity demand, installed capacity, and wholesale electricity prices per each measure/action and technology;
  - energy savings potential per technology and measure/action;
  - GHG emission reduction potential per technology and measure/action;
- Tables for the:
  - economic cost effectiveness of various high-efficiency technologies and measures/actions while taking into account the rate structure for different market segments, equipment hours of operation, as well as low and medium costs;
  - economic interest and high impact of the proposed EE measures/actions and technologies from the sectors/consumers/end user perspectives (including paybacks);
- Previous energy audits conducted in government facilities, if existing, will be reviewed to support the determination of EE potential in the existing building sector.

The results obtained by the use of such an Excel tool will serve to define an impact scenario through the implementation of identified measures/actions and technologies that will be compared with the business-as-usual scenario.

Assessing and selecting EE measures

Evaluating and selecting the measures can sometimes be more complex; it can be fast and intuitive or involve an in-depth analysis of each option. The degree of accuracy of the evaluation process is most often dependent upon the importance of the decisions that must be made. This importance can be measured in terms of the estimated financial resources required, the desired impact on the load curve or how difficult making an optimal choice turns out to be when several options are available.

Assessing the potential

Analysing a program as a whole requires a cost/benefit analysis that includes evaluating the energy-saving potential of each of the measures proposed. In order to determine the true potential of a measure, the planner proceeds with the evaluation of two intermediate factors: the measure's technical potential and a combination of its technical and economic potentials.

4.1.7 Creating an EE Fund (EEF)

With regard to financial incentives, the government could establish an Energy Efficiency Fund to support programs and activities that are aimed at the improvement of energy efficiency in all sectors of the economy. The Fund will be managed by the government and could be envisaged to be used to extend loans at affordable interest rates, give interest subsidies on commercial loans for energy efficiency investments, provide grants for certain activities (e.g. energy audits) and fund any of the activities that will be defined later in the strategy.

The Fund could support a number of activities including energy efficiency project development and implementation and related consulting services in industry and commerce, research programs on energy efficiency and capacity building. The Fund could also support public information campaigns on energy efficiency, financing programs for energy-efficient technologies, energy saving equipment for public buildings and efficient urban street lighting.

Further details are provided in the EE credit facility guidelines prepared as part of the ESREM project.

4.2 Program Design

When the planning phase is over and the most suitable DSM measures have been selected for the market, the planner can move to the next step, the program design.

In many cases, electricity companies design and implement DSM pilot programs before developing large-scale programs in order to test program mechanisms and the practical aspects of their operations. Although the objectives of pilot programs differ from those of large-scale programs in terms of quantity, they share the same operational concepts.

4.2.1 Program Concepts

Program concepts include the following components:

- Program description: overview of the concept and identifies the target market, the technology-based measures to be implemented, the incentive structures for the end-user, and the program's marketing strategy.
- Marketing and implementation strategies: detailed description of the activities and strategies suggested to reduce any market barriers that would impede a measure's acceptance and to foster a high level of participation in the program.
- Incentives: the type and level of financial incentives that would be initiated in terms of qualitative and financial benefits.
- Target market: estimates of the size of the target market, the desired rate of market penetration, the required level of participation, and of how consumer participation will grow over time.
- Load impact: estimate of the seasonal and daily impact of the program on the power demand and energy consumption of a participating consumer and of the total number of participants.

4.3 Program Implementation

The implementation stage involves increasing the services offered by electricity companies. These services include marketing, customer relations and support, and technical as well as financial activities. The implementation of these programs may also support some of the activities that electricity companies offer normally.

4.3.1 Involving the Decision-makers

The sources of any DSM program depend greatly on the involvement of political representatives as well as corporate decision-makers, especially those dealing with power distribution.

Very often, DSM programs suffer considerably due to differences of opinion between the government and electricity companies, thus commitment of the utility's top management to the program is essential.

4.3.2 Defining Implementation Means

Human resources

It is often necessary to add new expertise and resources, which means that recruiting new staff and training project team members will become important aspects of the implementation process. The staff involved in the day-to-day operation of the programs will also require training to ensure a higher degree of efficiency.

Financial resources

Among the business allies most likely to actively participate in DSM programme implementation, ESCOs enjoy a special status. These companies are specialised in the areas of implementation and financing; they also give guarantee to the performance of DSM programs.

Furthermore, international financial resources can be involved, such as International financial institutions and development agencies, bilateral agencies, related funds, sector-based agencies and organisations.

4.3.3 Developing Market Activities

The dissemination of DSM programs requires proper marketing activities and strategies by considering product, price, promotion and place of transaction.

Marketing tools will establish the detailed marketing procedures and supervise the production of promotional material to be used for launching the program: printed information (brochures, newsletters, posters, etc.), direct contact with the consumers (conferences, seminars, etc.), and publicity (newspapers, advertisements, interviews, etc.).

4.4 Program Evaluation

The objectives of program evaluation are:

- To assess the technical impact of programs and whether they meet the set objectives.
- To maintain the quality of results and goods delivered by the current programs.
- To detect program shortcomings and suggest ways of optimising program operations.

During the program planning an evaluation plan should be prepared to identify objectives to be evaluated and resources. During the program implementation, target samples should be identified, and data analysis conducted. The implementation process should be reviewed and updated.

DSM program evaluation activities include the evaluation of the following three components:

- The process: it concerns the effective management of the program, the program's operational procedures, the involvement of business allies, the influence the program has on the market and consumer satisfaction.
- The impact: it has the objective of judging the level of consumer participation and the impact the program has on energy as well as on the demand in each of the target markets.
- The market: it concerns the non-financial benefits associated with individual programs, such as changes in the consumer's proximity, image improvements, increasing consumer

activities, environmental gains, reducing risk factors and other benefits (social, employment) as well as the data associated with the relative success of the communication programs.

Appendix A - Determine the typical load curves

When a DSM programme is being planned by an electricity company, it is important that the target load-curve objectives be established beforehand, which means that the utility should determine the effects that will be beneficial to the financial and operational status of the company. These objectives are defined on the basis of an in-situ survey that involves the collection of preliminary data. The first and foremost source of data for DSM planning is the utility's ongoing operations and they are vital for the management, planning, and optimal use of its power production, transmission and distribution means.

Production

- Electricity consumption in proportion to the overall energy consumption of customers
- Proportion of the different primary energy sources used for electricity production
- Growth perspectives for prices and fossil fuel supply conditions for power stations
- Capacity of each power station, annual production, the year it was established, production costs
- Portion of electricity production through independent sources
- Urban/rural/average electrification rate
- Annual rate of electricity exported/imported
- Efficiency of metering and billing systems
- Advance planning for equipment and long-term marginal production costs

Performance

- Stock status in power stations by category
- Power station maintenance conditions and expected lifespan
- Conversion output of power stations
- Rate of use of power stations
- Relative losses in transmission and distribution networks
- Losses in transformers and alternators
- Losses related to network operations
- Appropriateness of transformer sizes for the load
- Condition and suitability of conductor section for the load
- Quality of power distributed over network

When preliminary information about the utility's current situation has been compiled, the planner can begin an initial analysis. The first task is to understand the power demand and consumption structure; the planner will study the distribution of demand according to the sectors of activity and the end-use of the power. It is also important to examine the daily power curve during peak periods and the curve's seasonal variations. Energy demand and consumption are the two elements that define the actual nature of the demand.

The processed data are used to draw curves showing load variations at different times. These load curves can represent the entire system or a particular activity sector, or even a more specific component in a particular sector, such as a factory or a residence.

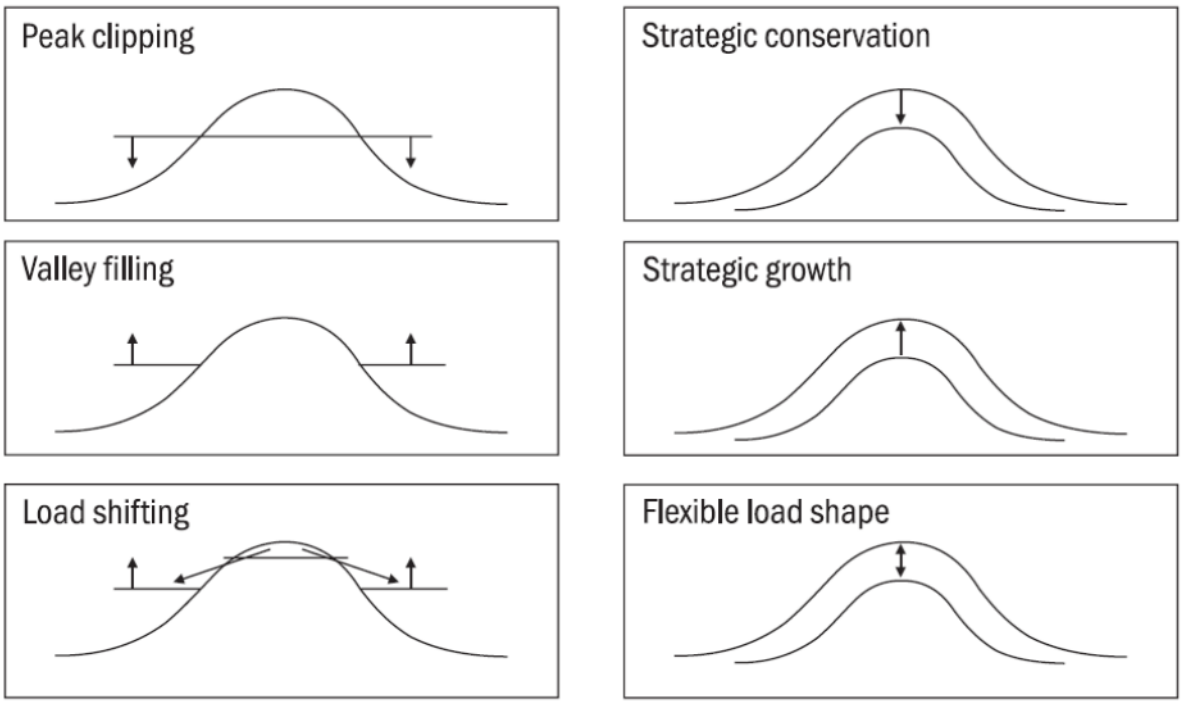
During the analysis, the planner must also identify situations where there are two peak demand periods instead of one. In fact, in several countries or regions, the daytime peak period is as significant as the evening peak period. This phenomenon has far reaching consequences on the design and cost-effectiveness of DSM programs since the end-users during the two peak demand periods may not the same. During the day, the peak period is often generated by the industrial, institutional, and business sectors whereas the evening peak is largely attributed to the residential sector. To reduce its peak demand, the electricity company must design energy efficiency programs that address both types of end-users. The load-curve modification objectives include the following options:

- Peak clipping: involves reducing the peak demand for electricity at specific periods and is one of the most traditional means for load management. Peak clipping is generally considered to be reducing peak loads through the electricity company's direct control on equipment used by the consumer or through tariff clauses whereby a consumer curtails his load at certain hours of the day. This procedure not only offers the possibility of reducing the need for installing additional power plants,[30] but it also allows to reduce the operational costs of power stations and, to a certain extent, the dependency on fossil fuels (such as natural gas, heating oil) for generating electricity.
- Valley filling: involves increasing the load during off-peak hours, which proves to be particularly interesting in cases where the long-term marginal production costs are less than the selling price of electricity. Under these conditions, adding loads at a reasonable rate helps to reduce the overall cost price of electricity. For instance, one of the ways of increasing energy consumption during off-peak hours (valley filling) is to design buildings with thermal storage facilities, which can generate demand during off-peak hours or to offer special rates (tariff clauses) favouring load increases during off-peak hours only.
- Load shifting: as the name suggests, is shifting peak period loads to off-peak hours. The most common applications of this measure are related to heating and air-conditioning. Shifting load demands associated with thermal storage involves load shifting related to conventional electricity applications (for example, building heating by electric convectors).
- Strategic conservation: of electricity is one of the non-traditional approaches to load management and involves activities undertaken by electricity companies for the purpose of directly reducing the end consumption. Besides being a load management activity, it also involves a decrease in sales as well as modifications in the way electricity is used. It is easy to understand the 'strategic' aspect of conservation since most electricity companies are unlikely to want a decrease in their sales.
- Strategic growth: results in an overall increase in sales. This is also one of the non-traditional approaches to load management. It may mean an increased use of electricity on the energy market through the development of new applications (electric cars, microwave technologies, automation). In some cases, an increase in the use of electric energy can be motivated by national objectives in terms of reducing the use of fossil fuels in countries where hydro-electric resources are significant.
- Flexible load shape: is a third non-traditional form of load management and it addresses problems related to the reliability of demand forecasts. Electricity companies are never guaranteed to balance their production capacity with the expected demand. They must make sure that they can curtail a consumer's load demand, if need be (either for an immediate need or as a constituent for their energy reserves), in exchange for various incentives. The customer must then produce his own electricity or use other energy sources to meet his demands.

These objectives are illustrated in Figure A- 1.

[30] Because it is difficult to store electricity, the creation of new power stations depends on the peak demand and consumption rate of electricity and not on the average yearly consumption rate.

Figure A- 1: Load-curve modification objectives



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