Needs Assessment Study on Energy Efficiency in the Southern African Power Pool

Final Report

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Acronyms

ABOM	Agreement Between Operating Members
AC	Alternating Current
AMR	Automated Meter Reading
AS	Ancillary Services
BPC	Botswana Power Corporation
CDE	Centre for the Development of Enterprise
CEC	Copperbelt Energy Corporation Plc
CER	Commission for Energy Regulation
CFL	Compact Fluorescent Light
CUE	Cost of Unserved Energy
DAM	Day Ahead Market
DESCO	Dhaka Electricity Supply Company
DFID	Department for International Development
DMP	Demand Market Participation
DNO	Distribution Network Operator
DRC	Democratic Republic of Congo
DSM	Demand Side Management
ECB	Electricity Control Board
EE	Energy Efficiency
EEMP	Efficiency Energy Management Programme
EEO	Energy Efficiency Obligation
ERB	Energy Regulation Board
EU	European Union

EUEI PDF	European Union Energy Initiative Partnership Dialogue Facility
EWURA	Energy and Water Utilities Regulatory Authority
FTP	File Transfer Protocol
GEF	Global Environment Facility
GIZ	Gesellschaft für Internationale Zusammenarbeit (GIZ)
H&V	Heating and Ventilation
HPP	Hydro Power Plant
HV	High Voltage
HVDC	High Voltage Direct Current
IDM	Integrated Demand Management
IEC	International Electrotechnical Commission
IEE	Industrial Energy Efficiency
IPP	Independent Power Producers
IRP	Integrated Resource Plan
IRR	Internal Rate of Return
KPI	Key Performance Indicators
LRMC	Long Run Marginal Costs
LV	Low Voltage
M&E	Monitoring and Evaluation
M&V	Measurement and Verification
MV	Medium Voltage
MD	Maximum Demand
NAD	Namibian Dollars
NDPL	North Delhi Power Ltd

NEEA	National Energy Efficiency Agency
NEEAP	National Energy Efficiency Action Plan
NEEP	Namibia Energy Efficiency Programme in buildings
NEP	National Energy Policy
NERSA	National Energy Regulator of South Africa
NGO	Non-Governmental Organisation
NPV	Net Present Value
OCGT	Open Cycle Gas Turbine
PF	Power Factor
PRP	Power Rehabilitation Programme
PSC	Planning Sub Committee
RED	Regional Electricity Distributor
REECL	Residential Energy Efficiency Credit Line
REEEI	Renewable Energy and Energy Efficiency Institute
REEEP	Renewable Energy and Energy Efficiency Partnership
RERA	Regional Electricity Regulators Association of Southern Africa
RSA	Republic of South Africa
SADC	Southern African Development Community
SANEA	South African National Energy Association
SAPP	Southern African Power Pool
SAPP-CC	Southern African Power Pool Coordination Centre
SCADA	Supervisory Control and Data Acquisition
SDC	Swiss Agency for Development and Cooperation
SEC	Swaziland Electricity Company

SECO	Economic Cooperation and Development Division at the State Secretariat for Economic Affairs
SERA	Swaziland Energy Regulatory Authority
SME	Small and Medium Enterprises
SNEL	Société Nationale d'électricité
SVC	Switchable VAR Compensation
SWH	Solar Water Heaters
T&D	Transmission and Distribution
TANESCO	Tanzania Electric Supply Company Ltd
TB	Terra Bytes
ToR	Terms of Reference
ToU	Time of Use
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
US$	US Dollar
VPS	Virtual Power Station
VSD	Variable Speed Drive
WB	World Bank
WEC	World Energy Council
ZAR	South African Rand
ZERA	Zimbabwe Energy Regulatory Authority
ZERC	Zimbabwe Electricity Regulatory Commission
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	Zambia's Electricity Supply Corporation

ZETDC	Zimbabwe Electricity Transmission and Distribution Company
ZMK	Zambian Kwacha
ZPC	Zimbabwe Power Company

1 Introduction

PPA Energy has been commissioned by EUEI PDF, on behalf of the Southern African Power Pool (SAPP), to undertake a Needs Assessment Study on Energy Efficiency in the SAPP region. This final report presents the final set of recommendations, taking account of feedback received from SAPP members during and following the first workshop on 29th April 2012 and the second workshop on 27th June 2012.

This introductory section presents the project context and background, the project objectives and the structure of this report.

1.1 Context and Background

In recent years, the SAPP region has been experiencing power generation deficits. This is attributable in part to increasing demand, as SAPP member countries develop economically and electrification projects are implemented, to facilitate this economic expansion. This has been coupled with prolonged processes for the commissioning of new generation. There have been generation shortages in South Africa since around 2007. South Africa is dominant in terms of generation capacity in the region; installed capacity in South Africa accounts for almost 80% of installed capacity in SAPP member countries.[1] South Africa exports power to several other SAPP member countries, so the impact of generation shortages in South Africa potentially have an impact on the region as a whole.

Infrastructure projects required to support this demand increase, and to address capacity shortages, require significant investment and have long lead times, which are prone to delays in all stages of project development. Generation, transmission and distribution investments may not be realised in time to address the demand increases. It is widely acknowledged that implementing energy efficiency measures can be more cost effective than capacity expansion projects, and can be implemented on a shorter timescale. SAPP has recognised this, and – in the Terms of Reference (ToR) for the current assignment – has requested a review of energy efficiency measures in the region as a means of addressing challenges in the power sector in the short term. Implementing energy efficiency measures in the SAPP interconnected system is a sustainable activity, as it ensures that when electricity generation measures are considered, the electricity generated will not be wasted. Furthermore, energy efficiency can reduce generation that has a negative impact on climate change.

This study considers the implementation of projects in the region as a whole, as opposed to focussing on individual SAPP member countries. This approach

[1] SAPP Annual Report 2010

recognises that there may well be common themes across the region, in terms of appropriate programmes to consider for implementation. There is also the benefit of economies of scale if the same programmes are rolled out on a regional rather than country basis.

1.2 Objectives and Activities

The objectives of the study are clearly defined in the ToR (see Appendix 1) and are reiterated as follows:

- To enhance the use of energy efficiency measures in the SAPP power system;
- To provide a basis for decision-making on appropriate interventions at the regional level; and
- To provide recommendations on high priority energy efficiency projects to be implemented at regional level.

PPA Energy has been tasked with undertaking the following activities:

- Review current and proposed energy efficiency programmes
- Conduct a Needs Assessment Survey
- Prioritise projects for implementation:
    - Identify Energy Efficiency and Demand Side Management projects
    - Evaluate and identify viable projects
    - Assess opportunities, constraints and costs
    - Formulate a project pipeline and recommend high priority projects

PPA Energy's analysis and recommendations are presented in this report.

1.3 Structure of this Report

The structure of this report is as follows:

- Section 2 of this report provides background on Energy Efficiency and Load Shifting, and defines Energy Efficiency and Demand Side Management;

- Section 3 of this report discusses supply side constraints in the SAPP region;

- Section 4 presents a review of current and proposed energy efficiency and Demand Side Management projects that were discussed during the four-country visit;

- Section 5 summarises the results from the Needs Assessment survey; and

- Section 6 contains the evaluation and prioritisation of Energy Efficiency measures considered for co-ordination by SAPP.

The Executive Summary and Appendices are presented in a separate volume.

The Appendices are:

- Appendix 1: Terms of Reference;

- Appendix 2: Needs Assessment Survey;

- Appendix 3: Summary of Needs Assessment Survey responses;

- Appendix 4: Review of Current and Proposed Projects; and

- Appendix 5: Full Project Evaluations.

2 Energy Efficiency and Load-Shifting Background

2.1 Categories of Energy Efficiency Measures

Energy Efficiency projects can be considered as being either supply side (i.e. system operation, generation, transmission or distribution functional areas) or demand side (i.e. direct and indirect energy consumption). These areas can be further segmented, by categories of users / assets, as illustrated in the framework below.

<table>
<tr><th colspan="2">Supply Side</th><th>Demand Side</th></tr>
<tr><td colspan="2">HV Grid and System Operation</td><td>Industrial</td></tr>
<tr><td>MV Technical</td><td>MV Non-technical</td><td>Commercial and industrial</td></tr>
<tr><td>LV Technical</td><td>LV Non-technical</td><td>Residential and commercial</td></tr>
</table>

Figure 1. Supply and Demand Side areas

Examples of energy efficiency projects being implemented in these different categories, in developed and developing economies, are discussed below.

2.2 Supply Side

2.2.1 High Voltage (HV) Grid and System Operation

At the HV level, generation and transmission efficiency can be considered. Thermal power plant efficiency can be improved with minor and major upgrades to components. Examples of the former include combustion tuning and upgrading control systems; and the latter can include upgrading boilers and turbine blades.

An American company, which is engaged in the development of technologies for air pollution control, process optimisation and combustion efficiency, has shown the efficiency of two units from a thermal plant improving by 2%

following turbine upgrades and a further 3% following a control system upgrade.[2]

Transmission lines can be upgraded, or new lines built, which could relieve overloaded lines, and avoid the need to dispatch less efficient generation due to transmission constraints. The use of HVDC lines, where they are more economic than AC transmission, can be considered for large bulk transfer of power, resulting in lower line losses.

There is also potential for energy efficiency measures in the System Operator function, by introducing policies that encourage the optimisation of generation scheduling and dispatch, and regional sharing of reserve margins. Energy Regulators in Great Britain and Ireland are encouraging optimal dispatch using performance measures, encouraging regional trading through common markets rules, and the sharing of operating reserves.

2.2.2 Medium Voltage (MV) Grid

Loss reduction in Medium Voltage distribution lines, as with the LV system, can be categorised as technical and non-technical losses. Loss reduction programmes are a common method of improving energy efficiency in distribution networks.

Technical loss reduction measures include improving lines losses (e.g. correcting conductor sizes, identifying and correcting loose connections and joints, power factor correction) and improving distribution transformer losses (e.g. improving cooling, maintenance practices, under- or over-loading). Non-technical loss reduction measures include tackling meter faults, billing errors and revenue collection losses, for customers with MV connections.

North Delhi Power Limited (NDPL) is an example of a distribution utility that has successfully managed to reduce and maintain lower levels of losses. Losses have been reduced from 53% in 2002, when NDPL was founded, to around 13% in 2011. Measures in their loss reduction programme include: implementing an Advanced Metering Infrastructure for customers with demand at or above 15 kW; and installing Medium Voltage Distribution networks in areas that are prone to theft.[3] Similarly, the Dhaka Electricity Supply Company Ltd (DESCO) also had a successful distribution loss reduction programme; losses reduced from 46.7% in 1998 to 8.8% in 2011.[4]

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[2] Energy Efficiency Improvements: Supply Side Optimisation Translates into Reduction in CO2e; Fuel Tech Inc.; March 2010

[3] Reducing Technical and Non-Technical Losses in the Power Sector; Background Paper for the World Bank Group Energy Sector Strategy; July 2009

[4] Dhaka Electricity Supply Company website: www.desco.org.bd

Another initiative is the US Department of Energy introducing energy efficiency standards for distribution transformers in 2007. Transformers that do not meet the standards cannot be sold for use in the US. Leading manufacturer ABB claims that the impact of the standards is a 4% improvement in efficiency compared with previous standards; given that there are over 40 million distribution transformers installed in the US, the potential for efficiency savings are significant.[5]

Introducing minimum standards can be particularly effective in certain areas where the sale of low quality distribution transformers is widespread, and benefits can be seen in reliability, as well as energy efficiency improvements. Very significant transformer failure rate improvements have been realised in North Delhi and Dhaka, following change-out programmes.

2.2.3 Low Voltage (LV)

Measures that utilities can take to reduce losses at LV can include those discussed above for MV distribution. In addition to this, utilities can also consider balancing phases to reduce losses. Non-technical loss reduction can be a significant issue at LV, and so measures to address metering and billing problems at LV can have a considerable impact on loss reduction. Measures can include: tackling illegal connections; reviewing meter testing and certification procedures; meter replacement programmes; consideration of the use of pre-payment meters; reviewing meter access and visibility; reviewing the billing process; inactive account management; the use of aerial bundled cables or coaxial cable drops to deter illegal connections; and the use of two part meters to eliminate meter bypassing.

Continuing with the example of NDPL in North Delhi, measures in their loss reduction programme included: replacing old, erroneous meters with accurate electronic meters; and collaborating with Non-Governmental Organisations (NGO) to create awareness of the dangers of tapping electricity from live wires in areas of informal housing.

2.3 Demand Side

2.3.1 Industrial

Energy Efficiency measures that are particularly important for industrial customers include best practice Energy Management and standards for boilers, motors, ventilation, etc., and motor change-out programmes.

The United Nations Industrial Development Organisation (UNIDO) has an Industrial Energy Efficiency (IEE) programme, which has two core concepts:

[5] Energy Efficiency in the Power Grid; ABB

energy system optimisation and energy management standards. The UNIDO IEE programme provides training and assistance, e.g. in policymaking, to assist developing countries and emerging economies to adopt and implement energy management standards. UNIDO is implementing an initiative in South Africa, called the IEE Improvement Project. This is a collaborative initiative between the South African government (Department of Trade and Industry and Department of Energy), the Swiss Secretariat for Economic Affairs (SECO), and the UK Department for International Development. The project facilitates the implementation of a new South African Energy Management Standard (SAN/ISO 50001).[6]

Other international examples of industrial energy efficiency measures include compulsory energy audits for certain groups of industrial customers. The World Energy Council worldwide review of energy efficiency indicators, policy and evaluation presents summaries of a number of case studies of Industrial Audits.[7] Some form of mandatory industrial energy audits have been introduced in Algeria, Australia, Bulgaria, India and Taiwan. Characteristics of the programmes include:

- Mandatory energy audits (different countries applied this to different classifications of customer / organisation);
- Mandatory reporting;
- Mandatory action plans;
- Mandatory benchmarking;
- Mandatory certification of auditors; and
- Sanctions for non-compliance.

Energy audits for large customers were one of the current EE measures discussed with SAPP utilities on the four-country visit; details of these projects are presented in Appendix 4, and summarised in Section 5 of this report.

[6] Industrial Energy Efficiency Improvement Project brochure

[7] Annex 1 Case studies on Energy Efficiency Policy and Measures; Energy Efficiency: A Worldwide Review; World Energy Council in collaboration with ADEME; July 2004

2.3.2 Commercial

Typical Energy Efficiency measures that can be targeted at commercial customers include Building Codes; standards for equipment; and Energy Management.

In the UK, the Carbon Trust is a not-for-profit organisation that aims to assist businesses and the public sector to enhance their financial returns by cutting emissions, saving energy and commercialising low carbon technologies. The Carbon Trust Implementation Services and Siemens Financial Services offer financing options to businesses, such as loans, to help cut energy costs. For example, a furniture retailer was keen to make energy savings following price increases in 2008. They had a survey through the Carbon Trust, to identify how to make savings, and were eligible for a business loan to finance the initiatives. With a loan of £81,000, they were able to replace lighting throughout their stores and distribution centre, making savings of £41,000 per year (at 2008/09 prices). The Carbon Trust also produces Energy Management guides for industrial, commercial and public sector organisations.

Energy efficient lighting programmes were discussed with SAPP utilities during the four-country visit; details are presented in Appendix 4 and summarised in Section 5 of this report.

2.3.3 Residential

Typical Energy Efficiency measures that can be targeted at residential customers include Building Codes and standards for insulation; standards for appliances; and, behaviour interventions such as education and public information campaigns.

In common with a number of Caribbean countries, St Lucia recently launched a public energy campaign, including the distribution of a guide to saving energy. The guide was aimed at the public and businesses, with the objective of encouraging greater efficiency of energy usage. The guide covers cooling, lighting, transportation, and the use of renewable sources, giving the background, facts and tips.

The Residential Energy Efficiency Credit Line (REECL) in Bulgaria provides loans for households to make energy efficiency improvements.[8] REECL was developed by the European Commission, the European Bank for Reconstruction and Development and the Bulgarian Energy Efficiency Agency, and has funds of 40 million Euros. Home improvements include double glazing, insulation, efficient biomass stoves and boilers, solar water

[8] http://www.reecl.org/indexen.php

heaters, efficient gas boilers, and building-integrated PV systems. To give an example of the impact of the programme, 43% of the loans to date have been spent on double glazing, and the power generation equivalent saving is 4.4 MW.

2.4 Load-Shifting

Load-shifting is a load management technique that aims to move demand from the peak hours to off-peak hours of the day. Load-shifting is typically incentivised or controlled by the utility, where it forms part of Demand Side Management. An International Energy Agency working paper notes that:

"Properly done, load shifting helps meet the goals of improving energy efficiency and reducing emissions by smoothing the daily peaks and valleys of energy use and optimising existing generation assets"[9]

Six key successful "levers" of Demand Side Management, relating to both EE and load-shifting, have been identified:[10]

i. Tariff rates, e.g. Time of Use tariffs

ii. Incentives, e.g. free technology in the form of an in-home display

iii. Access to real-time information, e.g. through Smart Meters

iv. Utility controls on flexible load such as air conditioning and water heaters, e.g. ripple control

v. Education and marketing

vi. Customer insights and verification, seeking feedback from customers to evaluate effectiveness

There are barriers associated with load-shifting, particularly for industrial consumers, which is why incentives need to be provided. These can include staffing issues; requesting staff to work during anti-social hours, possibly with an increase in workers' pay to compensate for this; and the unavailability of administrative and management staff outside core working hours. Load-shifting can also impact on clients and suppliers, as the measure can lead to reduced flexibility in production, and on neighbours, where noise associated with production can be unacceptable outside of normal working hours. These

[9] International Energy Agency working paper; Modelling load shifting using electric vehicles in a smart grid environment; 2010

[10] McKinsey on Smart Grid; Summer 2010

factors can render load-shifting options non-viable.[11] The details of any load-shifting measures need to be considered carefully, such as placing them on a voluntary basis, to provide for consumers for whom it is very difficult to change demand patterns.

2.5 Definitions

For clarity, Energy Efficiency and Demand Side Management are defined in the following paragraphs.

2.5.1 Energy Efficiency

In general, energy conversion efficiency is the ratio between the output of a given service or performance, and the input energy. For the purpose of this study, energy efficiency is the reduction of energy used to achieve a given service or level of activity. This can be achieved through technological changes (e.g. changing an incandescent bulb for a CFL, or changing a distribution transformer to one with lower losses), or through non-technical changes, such as improved organisation or management.[12]

The focus of this study is on Energy Efficiency in the interconnected SAPP system, to address regional supply-side constraints in the short to medium term, as well as climate change in the long-term. Therefore, energy efficiency in electricity generation, transmission, distribution and end-use is considered in this study.

As discussed in Sections 2.2 and 2.3, Energy Efficiency can cover supply and demand side activities. EE on the supply side can be called System Optimisation or System Efficiency, where the "system" is a transmission or distribution system, or a power plant. In this study the term supply side energy efficiency is used.

2.5.2 Demand Side Management

Demand Side Management (DSM) is the deliberate intervention by a utility on the customer-side of the meter to alter the customer's load profile. This includes reducing demand at peak times (load shifting) and reducing demand overall (reduce consumption and/or improve efficiency), i.e. DSM encompasses both EE and load-shifting measures.

The original focus of the study was on measures that are energy efficient, rather than load-shifting, and the initial results of this study were presented

[11] Orbis Environmental Pty Ltd; Load Shifting Opportunities Investigation – Final Report; 2006

[12] World Energy Council

during the first workshop in April 2012. At the first workshop, the SAPP-CC and SAPP members requested that this study should cover both EE and load-shifting measures. The scope of this report has therefore been revised to take load-shifting measures into account, which had originally been rejected in the initial screening on these grounds. The study also covers supply-side, as well as demand-side measures.

3 Supply Constraints

All countries that were visited on the four-country visit were anxious of impending, or on-going, supply constraints. The most severe case was Zimbabwe, where load shedding occurs every day at peak time, and recent load shedding figures show that the demand shed has ranged from 400 to 800MW. Load shedding was reported in Zambia, typically twice a week, and in Tanzania for 3 to 4 hours per day.

The severity of the capacity constraints can be seen in the following graph. This shows the net capacity for each utility, from 2010, plus planned generation projects (rehabilitation and new generation) against real peak demand in 2010 and forecast peak demand from 2011 to 2015.[13]

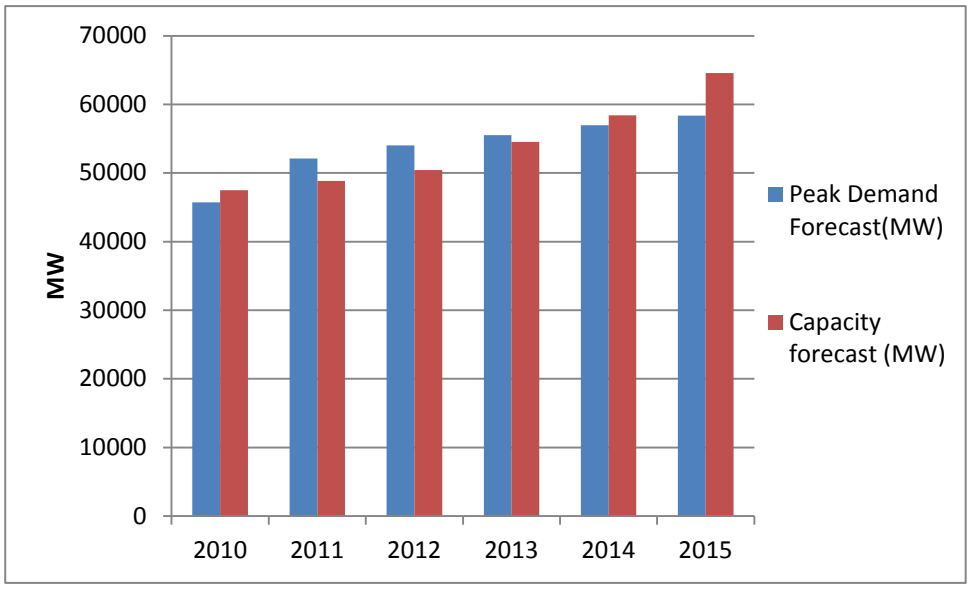


Figure 2. Capacity and peak demand forecast

The graph indicates capacity shortages in the whole region from 2011 to 2013, with a margin of 2.5% in 2014 and 9.6% in 2015.

It is not uncommon for infrastructure projects to experience delays, which can occur at all stages of the project, including obtaining funding and construction. Therefore a scenario has been considered whereby the planned generation projects are delayed by two years. The capacity shortfalls in this scenario are shown in the following graph.

[13] SAPP 2011 Annual Report

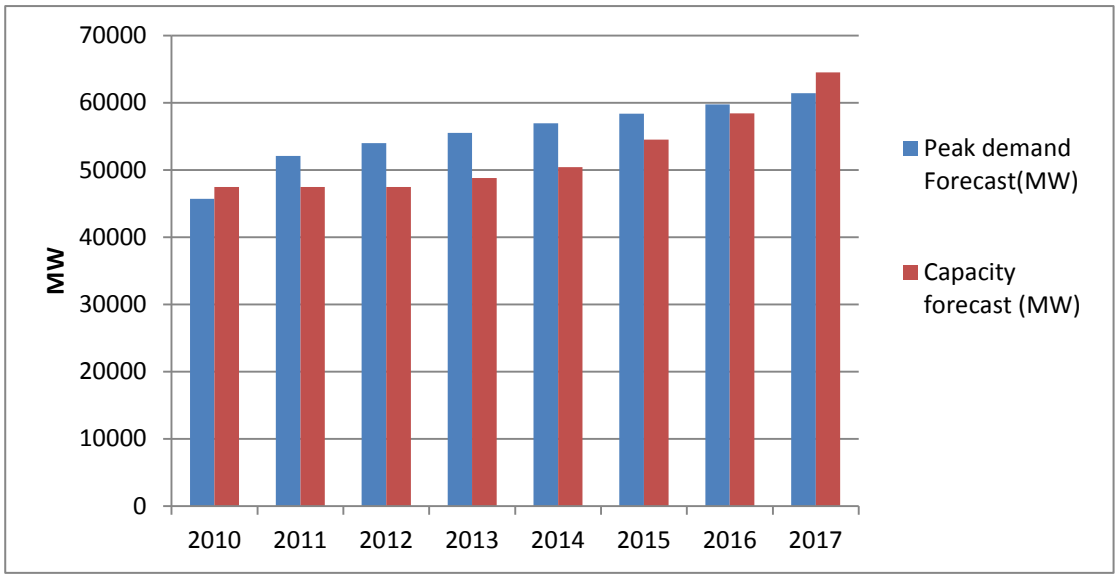


Figure 3. Capacity and peak demand forecast – delayed scenario

In this scenario, capacity constraints continue from 2011 until 2016, with a margin of 4.8% in 2017. The average capacity deficit in the period 2011 to 2016 is around 5,000 MW, peaking at a shortfall of 6,674 MW in 2013.

Considering forecast supply and demand from an energy point of view, the following tables shows the total energy demand forecast in the region, an estimate of generation sent out[14] (with the base case of generation built and rehabilitated as planned, and the 2-year delay scenario) and the potential energy shortfall.

Energy (TWh)	**2011**	**2012**	**2013**	**2014**	**2015**
Energy supply forecast (base)	278.1	287.2	310.5	332.7	367.6
Energy demand forecast	346.5	358.9	368.5	378.4	387.6
Supply-demand (base)	- 68.3	- 71.7	- 58.0	- 45.7	- 20.0

Table 1. Energy supply and demand forecast – base case scenario

[14] The average capacity factor in 2010 of SAPP net generation was 0.65. This factor has been applied to the forecast capacity to obtain an estimate of the forecast energy sent out.

Energy (TWh)	2011	2012	2013	2014	2015	2016	2017
Energy supply forecast (delay)	270.5	270.5	278.1	287.2	310.5	332.7	367.6
Energy demand forecast	346.5	358.9	368.5	378.4	387.6	396.5	405.4
Supply-demand (delay)	- 76.0	- 88.4	- 90.4	- 91.2	- 77.1	- 63.8	- 37.8

Table 2. Energy supply and demand forecast – delayed scenario

It can be seen that there is a significant energy shortfall forecast every year in both scenarios. This provides an indication of the magnitude of the capacity and energy shortfalls in the SAPP region, which the EE measures are aiming to address.

4 Needs Assessment Survey

4.1 Introduction

As part of this study PPA Energy has conducted a Needs Assessment survey on Energy Efficiency among the 13 members of the SAPP. A Needs Assessment aims to identify the needs of a group or population, in this case the users of the SAPP interconnected system, in order that recommendations for change can be made to meet future challenges.

The SAPP-CC indicated that they would like the SAPP members to form the participants of the survey. Background to the study and survey was presented at the DSM Working Group meeting at the SAPP general meetings in Livingstone, at which it was decided that the Planning Sub Committee (PSC) members would be the responsible parties for completing the questionnaire.

A key aim of the survey was to understand in which areas of the power sector the SAPP utilities believe there is the most potential for energy savings, and more specifically which Energy Efficiency measures the SAPP utilities believe will be most effective in the region.

The survey was structured to cover the following areas:

- An introduction to the study and survey;
- Understanding the user – an indication of the size of the respondent and their use of SAPP services;
- Understanding the problem – whether the respondent agrees with a set of problem statements;
- Options for change – trying to gauge which EE measures the respondent believes would be useful, and which they would prioritise; and
- Other comments – an opportunity for the respondent to indicate views that had not been captured elsewhere in the survey.

The full survey is in Appendix 2 and a summary of responses in Appendix 3.

Eleven responses were received from the utilities, which corresponds to a response rate of 85%. This is a good response rate, which allows interesting conclusions to be drawn from the survey. The results from the survey are presented in this section.

4.2 Understanding the User

In the initial section of the questionnaire, called "Understanding the user", key data was requested from the utility, about the way they use energy and their use of SAPP services. A summary of this data can be seen below.

4.2.1 Key Data

The following set of graphs illustrates the key data that was received from the utilities, which give an indication for the size of the utility.[15] These responses show that the survey captured views from a wide range of sizes of organisation, and so the results should be representative of the views of the SAPP members.

It can be seen from the first two graphs that for BPC the maximum demand in 2011 was higher than the installed capacity. It is also understood from the four-country visit that TANESCO, ZESA and ZESCO are experiencing supply shortages that frequently lead to load-shedding.

It is noted that there are some discrepancies between the capacity and demand figures presented, based on the data provided in the survey, and the data in the SAPP annual report. For completeness, a graph has been included showing installed capacity against peak demand based on data from the SAPP annual report (Figure 6).

[15] Note: The CEC installed capacity refers to the import capacity; the ZESCO peak demand represents suppressed demand; the NamPower installed capacity includes import capacity – installed generation is 508 MW.

Installed capacity - Peak demand

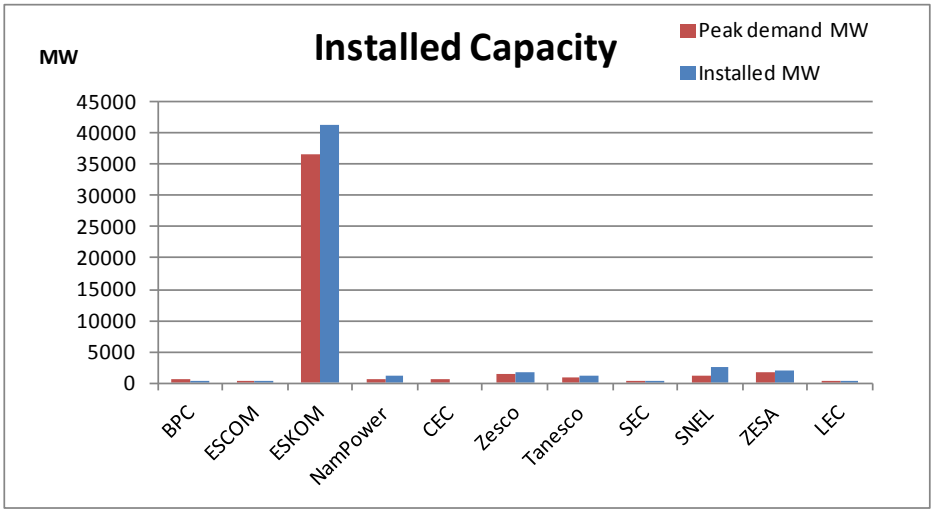


Figure 4: Installed capacity and demand – based on data provided in survey responses

Installed capacity – Peak demand (excluding South Africa)

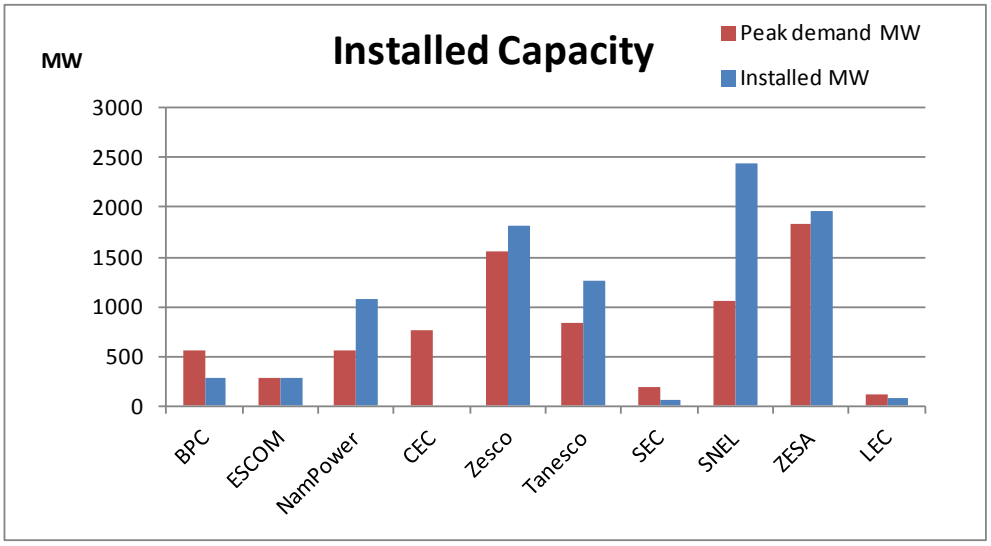


Figure 5: Installed capacity and demand (excluding South Africa) – based on data provided in survey responses

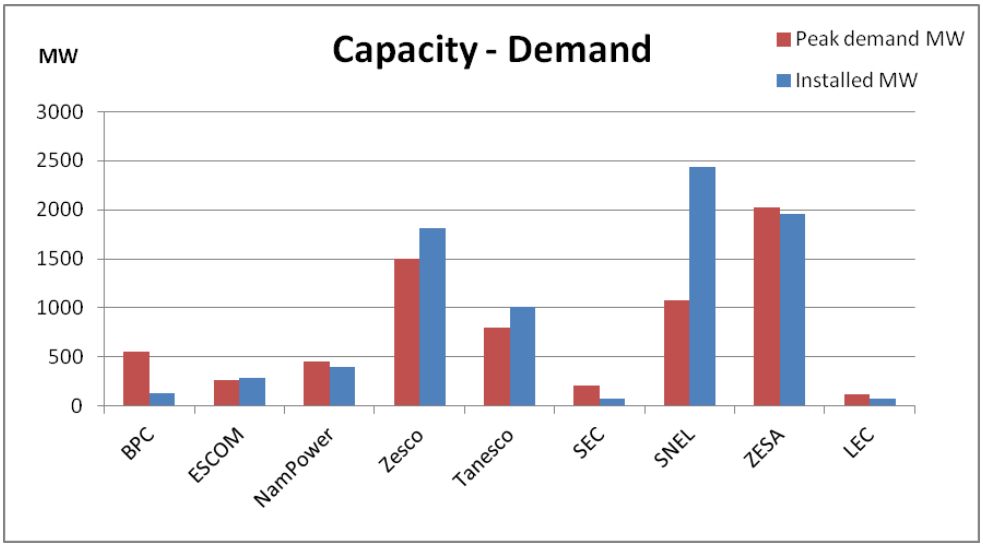


Figure 6: Installed capacity and demand (excluding South Africa).
SAPP Annual Report 2011 data

4.2.2 Operational Functions

The utilities were asked to indicate which areas of the power sector they operate in (generation, transmission, distribution, retail). All utilities that responded have generation and transmission functions; 91% have distribution functions and 45% have retail functions. EE projects that can be implemented in all functions will be relevant for consideration, although particularly those in generation and networks.

4.2.3 Use of SAPP Services

Utilities were asked to describe their use of SAPP services and the level of interaction they have with SAPP.

Three of the utilities that responded to the survey have no interaction with SAPP services, since they are not connected yet, or they have only just signed the Day Ahead Market (DAM) contract.[16] For the other utilities, some common observations have been highlighted:

- While most (connected) utilities use DAM service every day, the exchanges represent a small part of their total energy sales (from around 1% for most of them, to a maximum of 10% for ZESCO). One

[16] Note: the two utilities that did not respond to the questionnaire are different from the three utilities that responded to the questionnaire but make no use of SAPP services because they are not part of the interconnected system

utility indicated that, even if they submit bids frequently, they rarely get buyers because of the difference between the price offered and the price asked by buyers.

- The information exchange facilitated by SAPP has been highlighted as an interesting interaction.

- Several SAPP utilities noted the capacity building and training facilitated by SAPP, which is seen as a useful function.

According to 9 out of 11 utilities, their use of SAPP services will increase in the next few years.

This response supports the initiative that SAPP is taking to alleviate supply constraints and potentially make available more energy for regional trade.

4.2.4 National Energy Efficiency

A National Energy Efficiency agency is "*a body with strong technical skills, dedicated to implementing the national energy efficiency policy*" (WEC definition).

The only agency which has been referred to in the survey responses is the Swaziland Energy Regulatory Authority (SERA). SERA is implementing projects such as the introduction of Time-of-Use tariffs and prepaid metering. SERA has an annual budget of around US$10 million. It ought to be noted that, while regulators have a role to play in the EE arena, the role of regulator is different to that of an EE agency.

SNEL noted in "Other comments" that they are in the process of establishing a standing committee responsible for EE within the utility. SNEL noted that this study on energy efficiency in SAPP will be of great importance for them in implementing its energy efficiency programme and the establishment of this energy efficiency committee.

During the four-country visit it was reported that there is a Renewable Energy and Energy Efficiency Institute in Namibia, and similar organisations in South Africa (National Energy Efficiency Association and The Renewable Energy and Energy Efficiency Partnership). However, the majority of respondents have no such national agency co-ordinating energy efficiency measures in their country.

Experience from Europe and Asia shows that an Agency is needed to coordinate, promote and monitor EE. The response to the question posed in the questionnaire also confirms the view that there would be value in a co-ordinating role for EE project implementation, as a co-ordinating role may be lacking in most SAPP countries.

4.3 Understanding the Problem

In the second part of the survey, called "Understanding the problem", utilities were asked about their vision of Energy Efficiency, and the areas in which Energy Efficiency projects should be led, in order to maximise benefits.

4.3.1 Energy Efficiency Definition

Utilities were asked to define what Energy Efficiency means to them. It was commonly stated that Energy Efficiency refers to activities to get more work for the same energy, or to get the same work for less energy.

Nevertheless, there was some variation seen in the means to achieve Energy Efficiency among utilities:

- Some responses only referenced the supply-side; reducing the amount of energy required to generate, transmit and distribute electricity, by reducing losses.
- Other utilities only referenced the demand-side; influencing customers to change wasteful behaviour in terms of energy use and encourage them to use energy efficient appliances.
- Some utilities referred to both supply side (generation, transmission and distribution) and Customers aspects.
- It was noted that Energy Efficiency is not restricted to only considering electricity. However, in the context of this study, the focus is on EE projects in the SAPP interconnected system to address supply-side constraints.

It is essential that EE is carefully defined for the purposes of this project (see Section 2.5 of this report). As noted above, the study is specifically focused on EE measures in the SAPP interconnected system.

4.3.2 Problem Statements

Utilities were asked to indicate agreement or otherwise with a series of different statements regarding the formulation of the problem. Almost all respondents agreed with the following statements (presented in the form: *Statement (% of agreement among utilities)*).

- There are supply side constraints in the SAPP region (100%)
- The supply side constraints impact on my business / operations (100%)
- The SAPP region would benefit from supply side energy efficiency measures (100%)

- I see benefit in Energy Efficiency measures co-ordinated by SAPP (82%)

All utilities acknowledge the supply side constraints in the region and the impact on their operation. All utilities also acknowledge the potential benefit of energy efficiency measures. Almost all respondents see benefit in the co-ordination of those measures by SAPP.

These responses are supportive of the need for the project, and the co-ordinating role for SAPP. This is consistent with the message that was coming across during the four-country visit, where all stakeholders expressed support for the need for, and aims of, this study.

4.3.3 Areas with Greatest Potential for Energy Efficiency Savings

Utilities were asked to indicate the areas (e.g. generation, transmission, distribution, particular customer groups) in which they see the greatest potential for savings from Energy Efficiency projects.

For the eleven utilities that submitted survey responses, distribution was highlighted eight times as an area of great benefit for Energy Efficiency projects. The areas of customers, generation and transmission were mentioned 6, 4 and 3 times respectively.

Utilities were also asked to give specific examples where possible. The projects that were mentioned several times are:

- The implementation of CFL roll-outs in SAPP countries;
- Power factor studies; and
- The management of customer consumption (public awareness campaigns, development of residential meters, etc.).

EE measures in distribution networks have strong support from SAPP utilities, so it is important that these are considered in the project evaluation.

4.4 Options for Change

A list of 30 Energy Efficiency measures was proposed to utilities. Respondents were asked to select five of the measures that they believed would have the most impact.

To evaluate the results of the survey, an EE measure has been given 1 point when mentioned by a utility. The measures with the higher number of points are listed below:

- Distribution system – non-technical loss reduction programme (7 pts)

- Energy Efficient lighting regulation (7 pts)
- Distribution system – technical loss reduction programme (6 pts)
- Energy Saving Obligations – an obligation on suppliers to promote and stimulate investment in Energy Efficiency measures to save their customers energy (6 pts)
- Review tariff structures to be cost reflective and to incentivise efficient use (5 pts)
- National Energy Efficiency programmes with quantitative targets (4 pts)
- Time of day tariffs and smart metering (4 pts)
- Capacity building in implementing, monitoring and evaluating Energy Efficiency projects (4 pts)

As above, it is important that these EE measures, where they meet the relevant criteria, are considered in the project evaluation phase.

4.5 Other Comments

Respondents were given the opportunity to note other comments, where these had not been captured in the rest of the questionnaire.

Measures that utilities believe would be particularly effective include:

- Studies into, and implementation of, cost reflective tariffs in order to discourage high energy users (CEC);
- Increased participation of governments and the instruments they can use in encouraging energy efficiency (CEC);
- Renewable Energy, bio-energy and time-of-use tariffs (ZESCO);
- Reduction of technical and non-technical losses in transmission and distribution systems (SEC); and
- Capacity building in implementing, monitoring and evaluating Energy Efficiency projects is needed for all SAPP members (SNEL).

These are all interesting comments, which are taken into consideration in the project evaluation stage.

4.6 Summary of Needs Assessment Survey

The Needs Assessment survey was conducted on SAPP member utilities, in order to gather their understanding of the problem, and their view on potential EE solutions. The response rate has been high, at 85%. Utilities from all over the region, including those not yet interconnected to SAPP, have responded to the survey; the results should therefore be representative of the views of the SAPP members.

The amount of energy traded on the SAPP DAM currently represents a low portion of the energy sent out by utilities. However, (almost) all utilities stated that they foresee their use of SAPP markets increasing in the future. Respondents noted the benefits of other services provided by SAPP, such as training and capacity building. Most SAPP countries do not have a National Energy Efficiency agency, although some roles within other stakeholders were highlighted.

It is important to define EE measures in the context of this study, where the focus is on measures for the interconnected power system (focussing on the electricity vector of energy). There was strong support for all of the problem statements in the survey (supply side constraints impacting business, and perceived benefits of EE measures), which support the need for and aims of this study. The distribution system was highlighted as an area with great potential for energy efficiency savings.

Distribution loss reduction (technical and non-technical) was supported again in the prioritisation of specific EE measures, as well as cost reflective tariffs, Energy Saving Obligations and EE lighting regulations. These EE measures, where they meet the relevant criteria, are considered in the project evaluation phase.

5 Review of Current and Proposed Programmes

5.1 Introduction

For the four-country visit stipulated in the ToR, SAPP requested that the following countries should be visited; Namibia, Zambia, Zimbabwe and Tanzania. PPA Energy also visited a number of stakeholders in South Africa in-between these visits. The following is a summary of the meetings that took place in each country visit, the information gathered on current and proposed energy efficiency programmes and an assessment of the programmes discussed. More detailed information on the projects discussed during the four-country visit is presented in Appendix 4.

5.2 Namibia

5.2.1 Stakeholders visited

PPA Energy visited Windhoek, Namibia, from Sunday 5th – Wednesday 8th February. During this time, the following organisations were visited:

- NamPower (including Supply Business (Technical), Energy Trading, Marketing and Corporate Communications);
- The Renewable Energy and Energy Efficiency Institute (REEEI);
- The Regulator, Electricity Control Board (ECB); and
- A regional regulatory body, the Regional Electricity Regulators Association of Southern Africa (RERA) (Note: regional initiatives are discussed in Section 5.7).

5.2.2 General

There is activity in Namibia on Demand Side Management, with a number of players involved. The national utility and SAPP member, NamPower, has funded and led a number of initiatives. Activities have been undertaken by ECB, the Regulator, and the Renewable Energy and Energy Efficiency Institute (REEEI). The main driver for the measures taken so far has been the shortfall in generation capacity experienced both in Namibia and throughout the region. Namibia imports a significant portion of its electricity from South Africa, and therefore is particularly vulnerable to the power shortages there. It can be seen that many of the initiatives discussed below commenced during the South African power crisis of 2007. Another driver for the EE measures taken in Namibia, to-date, is the impending expiry of the contract with Eskom for the importation of bulk power in 2016.

NamPower referenced an annual event called Inter Power Games, which is a forum for sharing best practices, as well as a sporting event. Participating

countries include Namibia, Botswana, Swaziland and Lesotho. At the 2011 Inter Power Games, utilities presented on the challenges they are facing and the projects they are planning. NamPower stated that they are very open to sharing with other utilities their experience of the EE projects they have tried.

ECB has a mandate to encourage Energy Efficiency. They commissioned a Demand Side Management (DSM) study in 2006, which outlined a number of potential measures that could be taken. Many of the EE projects discussed in this section are based on suggestions from this study. The ECB also established and chaired a DSM steering committee, which assigned DSM projects to relevant stakeholders. The DSM steering committee became inactive, but there are plans to re-establish it in the near future.

ECB regulates electricity tariffs in Namibia. They have been moving towards cost reflective pricing, which is a key step in incentivising Energy Efficiency initiatives, as well as raising revenue for future investment required. According to ECB's Chief Executive Officer, *"It is logically predictable that electricity prices in Namibia, just like in most SADC countries, will continue to rise over the next five years".*[17] There is a cap on losses in the distribution tariff (10% combined technical and non-technical losses). ECB is considering moving towards incentive based regulation, where there could be opportunities to make Energy Efficiency a parameter (e.g. targets for EE in power stations).

The REEEI is a joint partnership between the Ministry of Mines and Energy and the Polytechnic of Namibia. Established in 2006, the REEEI has the objective of promoting Renewable Energy and Energy Efficiency in Namibia. Activities include campaigns, initiating and implementing projects (either directly or by contracting) and conducting pre-feasibility studies for RE generation projects.

The REEEI is co-facilitating an Energy and Environmental Partnership, which is a funding opportunity for Renewable Energy and Energy Efficiency projects in the Southern African region. This is a potential opportunity for SAPP to obtain funding for the co-ordination of regional EE projects.

In discussions with REEEI, it was understood that measures that could be taken to improve EE among industrial consumers have not been implemented, such as motor change out programmes. Some mines have their own Energy Efficiency units and programmes.

As well as the projects discussed below, it is understood from discussions with NamPower that the Ministry of Mines and Energy has a Solar Revolving

[17] Newsletter of NamPower; *Watts On*; 2010 3rd edition

Fund, which is a credit facility to stimulate the renewable energy market. Qualifying items include solar appliances for the home.

5.2.3 Current and Proposed Energy Efficiency Programmes

The current Energy Efficiency (EE) programmes that were discussed during the visit are summarised in the following table. More comprehensive information on each of the projects can be found in Appendix 4.

To put the figures below (e.g. costs and impact) into context, as of 2010 NamPower's maximum demand was 449 MW, sales were 3,648 GWh and annual revenue was US$310 million.[18]

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
CFL exchange programme	2007	NamPower	900,000 CFLs to main town centres	US$1.2 to 1.4 million	2 years	12-15 MW savings. Drop in max demand.
Energy Saving Campaign	2007	NamPower	Countrywide campaign	Max 2 MNAD (US$250k) / year	Ongoing	Raise awareness on Energy savings
Demand Market Participation	2007 / 2008	NamPower	6/7 DMP contracts in place (now expired)	Not known	Expired	Did not make use of contracts very often
Time of use tariff	2007, 2009	NamPower	Transmission connected customers (<30)	Not known	Quick to implement	Not known
Ripple Control	Not known	Walvis Bay, City of Windhoek	Municipality distributors (left)	Not known	Not known	More effective than CFL program
SOLTRAIN	2010	REEEI	50 demonstration systems in public institutions	Not known	Phase I : 2010 to May 2012	Enhance the use of sustainable energy

[18] SAPP Annual Report 2011

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
Namibia EE Programme in Buildings	End of 2010	REEEI	20 buildings EE pilot projects, 40 energy audits	US$6.1 million (assessed by UNDP)	3.5 years	1,828 MWh/yr savings. New EE buildings policy.

Table 3: Summary of current projects in Namibia

5.2.4 Planned Projects

NamPower is planning several EE projects, under a Short Term Critical Supply project, which covers the period 2012 – 2016. New base load generation is planned to be commissioned in 2016, so these planned projects cover the supply shortages during that period. They are also aiming to address increasing demand, regional power shortages and the fact that a number of bilateral agreements will be expiring in the medium-term. The first report on the Short Term Critical Supply project has been presented to the NamPower Board for approval. Detailed cost/benefit analysis has not been undertaken yet.

The project comprises a number of components, including:

- Power factor correction;
- Power plant refurbishment; and
- Renewable energy IPPs (two potential solar IPPs totalling 40 MW and two potential wind IPPs totalling 104 MW).

If the expected new baseload plant is not commissioned by 2016, when the current supply contract with Eskom expires, an interim solution could be to build a 300 MW coal plant.

Following the second workshop, NamPower provided an update on a Demand Side Management component of the Short Term Critical Supply project. A target will be set for MW savings to be achieved in a five year period; a number of likely actions to achieve these targets have been identified. A DSM implementation plan is due to be developed by September 2012. The implementation plan will detail the activities to be undertaken; estimates of savings; cost benefit analysis; analysis of funding options; timing issues for implementation; governance and organisational structure; and resourcing and budgets.

NamPower is also planning to roll out Solar Water Heaters in their own buildings and employee residences (in total 800 – 900 Solar Water Heaters).

Ideally the project would be wider (all government and public buildings), but the equipment is expensive, so they are starting with this smaller pilot project. It is noted that there is no tax relief on importing Solar Water Heaters. Tax exemptions on energy saving devices are being discussed at the SADC level.

The REEEI believes there is potential for EE improvements in distribution networks, in terms of loss reduction (technical and non-technical). They also cited smart meters as having potential scope for EE improvements in Namibia.

5.2.5 Qualitative assessment of EE projects in Namibia

As can be seen from the above tables, which summarise the projects discussed, quite a number and range of EE initiatives have been implemented in Namibia, and apparently with some success. The initiative to establish a DSM steering committee to assign projects to the most appropriate stakeholder seems sound, and it is encouraging to learn that the DSM steering committee is expected to be re-established soon. All of the projects discussed that have been implemented and/or are currently ongoing, focus on demand side initiatives. The only supply side EE projects that were referenced are a plan from NamPower for power factor correction and generation rehabilitation. As these projects are in the inception phase, details are not yet known.

The apparent success of the projects varies. NamPower believes some projects have been effective, such as the awareness campaign. The Demand Market Participation (DMP) contracts have not actually been used much since implementation, and have since expired, but NamPower believes there has been value in opening-up channels of communication with large users. Regarding the projects discussed with the REEEI, such as the Efficiency Energy Management Programme (EEMP) and the Namibia Energy Efficiency Programme in Buildings (NEEP), it is too early to assess the impacts of these.

NamPower stated that they have observed a reduction in peak demand in the order of 20 MW. However, in general, no baseline measurements have been taken for comparison, and it has not been possible to attribute peak demand reductions with individual EE projects. This was discussed with the various stakeholders, who now seem engaged with the idea of implementing the monitoring and evaluation (M&E) of EE projects.

As the impact of the projects is unknown, as well as the costs in many cases, it is not possible to appraise the cost and benefits of the various projects.

The sustainability of some of the projects needs to be considered. For example, the CFL distribution programme is subject to being undermined, if customers replace the CFLs with cheaper, incandescent bulbs when they eventually fail. To make this programme more effective, it should perhaps be supported by government policy, e.g. banning the use of incandescent bulbs. Other projects, such as SOLTRAIN, are capacity building, which should facilitate the roll out of Solar Water Heaters in Namibia in the long run.

However, projects like this can take longer to become effective, and quantitatively assessing the impacts can be difficult.

5.3 Zambia

5.3.1 Stakeholders visited

PPA Energy staff were in Livingstone between Sunday 12th and Friday 17th February, at the 38th SAPP general meetings. During this time, as well as presenting the project to the SAPP DSM Working Group, PPA Energy had discussions with the following organisations:

- ZESCO (DSM, generation and transmission); and
- The Energy Regulation Board (ERB).

PPA Energy staff were not able to meet with CEC during the general meetings. However, CEC has provided comprehensive information about their energy efficiency and DSM projects.

5.3.2 General

There are a number of utility companies in Zambia; the state utility, ZESCO; the private transmission company, Copperbelt Energy Corporation Plc (CEC); and Lunsemfwa Hydro Power Company Ltd. In ZESCO there is activity on both Demand Side Management and supply side initiatives. The supply side initiatives, in generation and transmission, could be of particular interest for this study. Again, the initiatives have been driven by supply side constraints in the country and region. Residential customers in Zambia are experiencing power cuts of around 1-2 hours, typically twice a week.

ZESCO is making a loss, as the tariffs are too low to recover their costs. There have been a number of tariff hikes over the past few years, and ZESCO has applied for another increase this year, which would allow them to make a small profit. A study was undertaken for ERB to assess the level of tariffs that would be cost reflective; ZESCO can apply for tariff increases until they reach this level. Moving towards cost reflective prices is a positive step for Energy Efficiency initiatives.

The Demand Side Management initiatives that ZESCO is implementing are similar to those implemented in other SAPP countries. However, in discussions with ZESCO it is understood that a number of supply side projects have been undertaken in order to improve, in particular, generation efficiency, and to increase the available capacity of generating plant. Significant gains in generation efficiency have been achieved.

In CEC, the focus of energy efficiency activity has been on the supply side, particularly in power factor improvement, although they have also been

involved in a number of DSM measures. Due to the requirements of their mining customers, CEC is required to maintain a highly reliable network; n-1 is adopted, line loadings are well within ratings, and consequently technical losses are low. All supply points are metered; meters are monitored from a central station and can be interrogated remotely. This ensures that CEC has an accurate idea of network flows and losses.

CEC has undertaken a Cost of Service Study and would like to implement cost reflective tariffs. They believe this is a key requirement for sustainable operation and development of the power industry, as well as a key incentive for industry players to implement EE measures.[19] In discussions with the regulator, ERB indicated that their understanding is that CEC is incentivised to maintain an efficient system, as they are operating on a commercial basis.

ERB has drafted a position paper, which they are submitting to the Department of Energy for approval, with a number of proposals on Energy Efficiency and demand response. ERB has introduced Key Performance Indicators (KPIs) to utilities as part of their tariff review. Of a larger set of KPIs, ERB is starting with five, including a KPI on losses and one on the number of customers metered (note that, currently, around 1/3 of customers in Zambia are not metered at all). For the past three years, there has been a "shadow scheme" of the KPIs, where the utilities can see what allowances they would have received if the KPIs were in use in the tariff review. Now, the five selected KPIs will apply, so the utilities' revenue will be performance based. The target for losses is to reduce them to less than 14% in distribution (current levels are 18 – 22%) and to 3 – 5% for transmission (current levels are in this band). Non-technical losses due to theft are a problem in the distribution network.

5.3.3 Current Energy Efficiency Programmes

The current Energy Efficiency (EE) programmes that were discussed during the visit are summarised in the following table. More comprehensive information on each of the projects can be found in Appendix 4. The tables containing information on CEC projects in Appendix 4 were provided by CEC.

To put the figures below (e.g. costs and impact) into context, as of 2010 ZESCO's maximum demand was 1,500 MW, sales were 9,631 GWh and annual revenue was US$236 million.[20] In 2011, CEC's peak demand was 758

[19] Information provided by CEC in a report, following the first workshop

[20] SAPP Annual Report 2011

MW, and customer consumption was 3,743 GWh. CEC's revenue in 2010 was US$167.3 million.[21]

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
CFL Distribution Programme	Nov 2011	ZESCO	1million CFLs, limit of 3 per household	US$2 million	Not known	66 MW savings
Solar Geyser Project	Planned	ZESCO and Palace Group	350,000 geysers to roll out	Not known	2 years	225 MW savings.
Energy Audits for Large Customers	Not known	ZESCO	7,000 customers	Not known	Ongoing	Reduce Energy usage and maximum demand. Improve PF.
Installation of prepaid meters	2007	ZESCO	All customers (470,000)	Not known	Depends on funding	Reduction in demand, losses reduced from 35 to 14%.
Power Rehabilitation Project	2000 2002	ZESCO	3 Hydro Power Plants (1600 MW)	US$275 million in total	4 to 10 years	10 to 20% gain in generating capacity
Transmission line upgrade	2011 2012	ZESCO	341 km of transmission line	Around US$100 million	Not known	Lower losses, double the capacity of the line
Power Factor Improvement Project – Phase 1	2009	CEC	90 MVAr capacitor banks at 66kV busbars	US$2.5 – 3.0 million	1 year	PF improve from 0.87 to 0.90, 42 MVA additional capacity, improved voltage and quality of supply

[21] CEC's response to the Needs Assessment Questionnaire

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
Power Factor Improvement Project – Phase 2	2012	CEC	120 MVAr capacitor banks at 11kV busbars	Not known	Around 3 years	PF improve from 0.9 to 0.96, 44 MVA additional capacity
Enhanced Power Factor for New Plants	Started recently	CEC	All mining customers to conform with PF requirement of 0.95	Not known	Ongoing	Depends on new demand
Public awareness campaign	In progress	CEC	Local and national media	Not known	Ongoing	Difficult to quantify.
EE Lighting	In progress	CEC	CEC institutional infrastructure and street lighting	Not known	Ongoing	Expected 60-80% saving on lighting consumption

Table 4: Summary of current projects in Zambia

In addition to the projects summarised above, ZESCO is running an energy saving campaign (through electronic and print media), has undertaken a distribution loss reduction project, and has Time of Use tariffs.

5.3.4 Planned Projects

ERB has written a position paper on proposed Energy Efficiency projects, which they are submitting to the Department of Energy for approval. The position paper encompasses the following proposals:

- Government should restrict the use of incandescent lamps across Zambia (e.g. by restricting manufacturing or entry into the country);
- All Government buildings should have Solar Water Heaters;
- ZESCO should install prepaid meters in all Government buildings;
- Appliance labelling and equipment standards should be adopted from established markets (e.g. Europe);

- A mandatory threshold for power factor should be set in the Grid Code (0.85), with a power factor charge applied (in the form of a kVArh charge) to customers below this threshold;

- Utilities should be encouraged to work with large consumers to improve energy efficiency (and in particular, should work with mines to encourage re-scheduling of non-essential load; mine loads account for around 50% of demand); and

- Time of Use tariffs should be introduced for Maximum Demand customers (demand shifting rather than EE).

It should be noted that this highlights the role that Regulators can play in the drive for EE in complementing the activities of utilities. For example, lobbying Government to restrict the use of incandescent bulbs makes the CFL change-out programme more sustainable. The regulator also has a role in using tariffs to incentivise performance in certain areas.

5.3.5 Qualitative assessment of EE projects in Zambia

The DSM projects discussed with ZESCO are similar to those undertaken in other SAPP member countries, mainly a CFL exchange programme, Solar Water Heating installations and Energy Audits for large customers. The planned timescales for the projects are either relatively short (2 years for the solar geyser roll-out) or currently on-going. ZESCO is the implementing body, although some of the projects are funded by lending agencies. ZESCO has calculated expected MW savings due to the CFL and SWH projects, which are 66MW and 225MW respectively. However, these are expected, rather than measured, savings. It is encouraging that as part of the CFL exchange programme, ZESCO is required to undertake post-project evaluation, as a condition of receiving World Bank funding. The total impact of the energy audits is not known, although individual examples were given. This highlights again the importance of Measurement and Verification of EE projects, in order that their impact and effectiveness can be evaluated.

ZESCO is undertaking a roll-out of prepaid meters, which they would like to extend to all customers, including around 1/3 of customers who are currently not metered. This project started in 2007, so it has taken place over several years, and is ongoing. ZESCO believes that customers with prepaid meters have an improved awareness of their energy usage, encouraging them to purchase energy efficient appliances. They have observed significant reductions in losses where prepaid meters have been installed, from 35% to 14%.

As well as undertaking DSM, ZESCO has also implemented a number of supply side initiatives, to improve the efficiency of generation and transmission. The generation rehabilitation projects have achieved significant gains in capacity, in the region of 10-20% of the original available capacity.

The cost of these projects is in the order of tens of millions of dollars (US$50-85 million); although cheaper than building new generation capacity, this is more expensive than the DSM initiatives discussed. ZESCO's rehabilitation projects have taken a number of years (4 – 10), although some rehabilitation measures could be implemented more quickly than others.

The focus of CEC's activities is in power factor improvement, on both the network and customer side. CEC has estimates of quantified benefits, either achieved or expected. As network losses are already low, focussing efforts on power factor correction seems a sensible approach. The additional capacity expected due to phases 1 and 2 of the power factor correction projects is over 80 MVA, which is around 10% of their peak demand. The other projects discussed by CEC, namely an awareness campaign and EE lighting programme, are similar to those implemented by other SAPP utilities. As with other utilities, CEC has not been able to quantify the benefits from these projects. They particularly mentioned the difficulty in assessing the benefits of the awareness campaign, as measures are being undertaken simultaneously.

ERB's planned projects are in the area of policy rather than implementation, and would support ZESCO's initiatives, if they are followed through. This highlights the important role that the Regulator can play in the EE arena.

There is currently no EE body in Zambia.

5.4 Tanzania

5.4.1 Stakeholders visited

PPA Energy visited Dar es Salaam, Tanzania, from Sunday 19th – Wednesday 22nd February. During this time, the following organisations were visited:

- Energy and Water Utilities Regulatory Authority (EWURA);
- The Ministry of Energy & Minerals;
- The Centre for Sustainable Modern Energy Expertise (TaTEDO); and
- The Tanzania Electric Supply Company Ltd (TANESCO).

5.4.2 General

There is very little activity on Demand Side Management in Tanzania, and even less on supply side energy efficiency. The Ministry, the Regulator and TANESCO each blame the lack of funding. Tanzania is experiencing severe power shortages, with daily cuts of 3 – 4 hours, but there appears to be a frustrating lack of initiative to implement EE until donors provide funding. The Ministry has formed an EE Working Group but they have not held any

meetings, and are waiting for funding from donors for travel allowances, international study tours, etc.

A study for TANESCO, undertaken by Hatch, was concluded in December 2011 and produced a shortlist of 9 demand and energy management programmes. Seven of these programmes address energy efficiency in specific areas:

- Household lighting programme;
- Industrial motors and variable-speed drive (VSD) programme;
- Commercial and institutional air conditioner programme;
- Energy-efficient household refrigerator programme;
- Refrigerated beverage vending machine programme;
- Industrial energy efficient audit and incentive programme;
- Additional industrial sector opportunities.

One aims to improve power factors:

- Power factor correction programme.

And one is designed to increase overall market awareness of energy conservation:

- Public awareness campaign.

TANESCO is seeking funding in order to progress these various programmes.

EWURA mentioned that TANESCO has an OCGT plant in the centre of Dar, which requires the use of a dummy load because the local demand is below the plant's minimum output. EWURA note that this is very inefficient.

Generally, EWURA say that the position in Tanzania is that many studies into EE have been done in Tanzania, but there has not been much action. They say that government (Ministry of Mines and Energy) is not providing the necessary lead on the issue.

5.4.3 Current and Proposed Energy Efficiency Programmes

The current and proposed Energy Efficiency (EE) programmes that were discussed during the visit are summarised in the following table. More

comprehensive information on each of the projects can be found in Appendix 4.

To put the figures below (e.g. costs and impact) into context, as of 2010 TANESCO's maximum demand was 802 MW, sales were 3,393 GWh and annual revenue was US$277 million.[22]

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
Power Factor Correction	2009	TANESCO	Large customers with AMR (T2,T3 tariff customers). Total T2 and T3 AMR meters installed to date is 2,335	US$ 9.8 million (The cost covers purchase of T2 and T3 meters, Meter boxes and AMR software)	2008 to 2012	(i) Enhance revenue collection, better metering and revenue protection method (ii)Increased system capacity and reduced system losses; Increased voltage level to consumers.
Public Awareness Campaign	2011	TANESCO	All customers (small-scale campaign) ; proposal for larger campaign	US$1.5 million for proposed larger campaign	Ongoing (eight years for proposed larger campaign)	28 MW savings from proposed larger campaign
T&D Loss Reduction	2004, 2007, 2010/11	TANESCO	Total losses have been identified at 24.3%	Not yet established	Six month study (2010/11) to identify losses	If proposed measures to reduce losses are implemented, it is expected to reduce total losses to 15%.
Tariff Application	2007	TANESCO	2007 Applied for 40.7% increase	Approved 21% tariff increase	One year	Cost reflective

[22] SAPP Annual Report 2011

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
			2010 Applied for 36% tariff increase 2011 Applied for 150% increase	Approved 18.5% increase Approved 40.3% increase	One year Three months	Cost reflective To cover expenses for emergency power plants
Rehabilitation of Hydropower stations	1999 to 2003	TANESCO	Kidatu Power Plant (204MW)	US$13 million	1993-2003	Available capacity increased from 175MW to 200MW, improved efficiency of 2% (24GWh annually), improved reliability

Table 5: Summary of projects in Tanzania

5.4.4 Planned Projects

As noted above, a study for TANESCO, undertaken by Hatch, was concluded in December 2011 and produced a shortlist of 9 demand and energy management programmes. Seven of these programmes address energy efficiency in specific areas:

- Household lighting programme;
- Industrial motors and variable-speed drive (VSD) programme;
- Commercial and institutional air conditioner programme;
- Energy-efficient household refrigerator programme;
- Refrigerated beverage vending machine programme;
- Industrial energy efficient audit and incentive programme;
- Additional industrial sector opportunities.

One aims to improve power factors:

- Power factor correction programme.

And one is designed to increase overall market awareness of energy conservation:

- Public awareness campaign.

TANESCO is seeking funding in order to progress these various programmes.

In addition to the above:

- Government of Tanzania (Ministry of Mines and Energy) is planning to introduce standards, labelling and codes of practice for energy appliances and equipment; and

- EWURA claim to have championed a CFL intervention, with the aim of saving 15-30MW from the evening peak demand, based on EWURA calculations. EWURA plans for a pilot CFL roll-out in one part of Dar failed due to a shortage of funds. Hatch propose the distribution of 815,000 high quality CFLs to residential customers of TANESCO. The programme would target residential customers, and cover over 50% of all TANESCO customers if the HATCH proposals are implemented. EWURA wanted to undertake a pilot, but they could not find funding for the US$2.5 per 15W CFL.

5.4.5 Qualitative assessment of EE projects in Tanzania

There are a number of players considering activities to support EE and DSM, including the regulator and Ministry of Energy and Minerals. However, as stated previously, there is little activity at present, and lack of funding is cited as the main reason.

TANESCO has implemented several DSM and EE projects, and with a mixture of supply and demand side activities; PF correction on networks and of large customers; an awareness campaign; loss reduction programmes; and rehabilitation to hydro generation. Power factor correction and loss reduction are not currently being carried out in the other utilities that were interviewed, according to discussions that were held with utility personnel, except for CEC and plans from NamPower in their Short Term Critical Supply project. Little is known about the costs and impacts of the projects currently being carried out, making it impossible to evaluate their effectiveness. The power factor correction measures were described as successful, but quantitative impacts are not known. It has been difficult to attribute success of the awareness campaign to savings, as has been seen with other utilities.

Similarly to the regulator in Namibia, TANESCO commissioned a study on priority demand and energy management programmes. However, none of these have been taken forward yet. The planned projects by the Ministry of

Energy and Minerals and EWURA, in appliance and equipment standards, labelling and cost of practice and CFL roll-out respectively, are of interest, but no progress has been made with these.

5.5 Zimbabwe

5.5.1 Stakeholders visited

PPA Energy staff were in Harare between Monday 20th and Tuesday 21st February. During this time discussions were held with the following organisations:

- ZETDC (Zimbabwe Electricity Transmission and Distribution Company) of ZESA (staff in System development, DSM, Environmental Planning, Tariffs);
- ZERA (Zimbabwe Energy Regulatory Authority); and
- The SAPP CC.

5.5.2 General

The Zimbabwe Electricity Supply Authority (ZESA) separated into functional areas following the enactment of the Electricity Act in 2002. The companies, which are subsidiaries of ZESA holdings, include the Zimbabwe Power Company (ZPC) and the Zimbabwe Electricity Transmission and Distribution Company (ZETDC).

ZESA is experiencing significant generation constraints, due to low availability of its own generation, as well as regional shortages. In 2009, available capacity was 53.4% of installed capacity.[23] This low availability is due to a combination of factors, including the advanced age of the power stations, lack of regular maintenance and finance shortages.

Load shedding occurs every day during peak times; recent load shedding figures show that the demand shed has ranged from 400 – 800MW (at which times power supplied is around 1,000MW). There are a number of capital projects planned to alleviate these constraints, but these will take at least 2-3 years to implement. ZESA is expecting around 1,400MVA of new generation capacity by 2015. In the meantime, they are rehabilitating existing generating plants to improve the availability, and planning DSM projects. ZESA would like to open up to IPPs, and there is interest from developers of renewable energy projects.

[23] Bizuneh Fikru for African Development Bank; Zimbabwe Infrastructure Flagship Report – Energy Sector; June2010

The optimisation of hydro resources for power generation in the region was discussed in meetings with ZESA. This is an interesting concept, and will be considered in the identification of projects for implementation by SAPP.

ZESA has identified priority transmission projects required, but lack of funding is an issue. There are transmission constraints, both internally and for regional trade. ZESA does not have an accurate idea of what their network losses are. They have developed a non-technical loss reduction strategy document, one of the outcomes of which is that they need to measure their losses, in order that they can best evaluate how to reduce them. ZESA would like to install meters across the network, and are undertaking a scoping study for this. It is understood, from the second workshop, that the meters have now been procured.

ZESA has been raising their tariffs over the last few years, but these are still not cost reflective. This situation is confirmed by the rates that IPPs are seeking in Zimbabwe. However, ZESA customers still consider the tariffs to be high.

The Zimbabwe Electricity Regulatory Commission (ZERC) was established in 2002, with a board appointed in 2005. However, after a three year term, the board was not renewed, and effectively there was no regulator. The regulator was re-established in 2011, as the Zimbabwe Energy Regulatory Authority (ZERA). ZERA is in the process of recruiting a Chief Executive Officer, among other positions, and is not currently playing an active role in EE initiatives.

Zimbabwe has a National Energy Policy (NEP), produced by the Ministry of Energy and Power Development. One of the objectives of the NEP is to *"Stimulate sustainable economic growth by promoting competition, efficiency and investment in the sector"*. The section on the Electricity sub-sector includes the following policy measures:

- Facilitate efficient use of existing infrastructure;
- Adopt a pricing mechanism for electricity that is cost reflective; and
- Adopt energy efficiency on the supply side.

Other EE strategies are referenced in the policy for different demand side customer groups, such as determining energy efficiency standards for buildings (households), promotion of energy efficiency and the development of holistic programmes (mining and industry) and incorporation of energy efficiency in building design (commerce). However, these strategies need to be implemented. The next phase of the NEP is to develop a National Energy Policy Implementation Strategy.

5.5.3 Current Energy Efficiency Programmes

The current and proposed Energy Efficiency (EE) programmes that were discussed during the visit are summarised in the following table. More comprehensive information on each of the projects can be found in Appendix 4.

To put the figures below (e.g. costs and impact) into context, as of 2010 ZESA's maximum demand was 2,029 MW, sales were 7,367 GWh and annual revenue was US$469 million.[24]

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
Generation rehabilitation	1987	ZESA	A single hydropower station (750MW)	US$40 million (1994 prices)	16 years	Increase in capacity by 84 MW
CFL exchange programme	Planned	ZESA	5.5M CFLs	US$13 million M&V included	3 months	180 MW and US$78 million savings
Installation of prepayment meters	2012	ZESA	All 600,000 domestic and small businesses	US$28 million	18 months	10% reduction in load, raise customer awareness
Ripple Control system rehabilitation	Planned	ZESA	227,000 customers	US$10.42 million	24 months	352 MW savings in peak demand
Time of Use tariff	2004	ZESA	1,000 large power customers	Not known	Not known	So far no reduction in demand has been seen

Table 6: Summary of projects in Zimbabwe

[24] SAPP Annual Report 2011

5.5.4 Planned Projects

ZETDC's transmission and distribution networks are in much need of rehabilitation and expansion. The transmission network in Zimbabwe is critical not only for local power supply, but also in facilitating regional power trade, due to Zimbabwe's central location in the SAPP system. The transmission constraints are causing wheeling congestion. ZETDC has a number of transmission projects that they would like to undertake. However, acquiring funding is the main challenge.

ZETDC would like to understand the level of losses on their network, as this is not currently known. They are currently conducting a scoping study into installing meters across their networks in order to monitor losses. This activity was a recommended outcome of their non-technical loss reduction strategy. The cost of installing meters at the transmission and sub-transmission levels was estimated to be around US$2.5 million, although recent figures show this is closer to US$4 million.[25] The outcomes of the scoping study will include the number of meters required, the start date of the programme, and the length of the programme. It is understood that the meters have now been procured.

ZESA has plans for generation rehabilitation. They would like to rehabilitate several of their generating plants, upgrading the technology so that a wider variety of fuels can be burned. They are also planning to install a number of small generating units (around 2 – 3 MW each) to the distribution network; as well as providing supply these will improve the voltage profile and reduce network losses.

The regulator, ZERA, is in the inception stages, and so is not currently undertaking any initiatives to promote EE. However, the role of ZERA will include setting KPIs and targets, including on losses.

5.5.5 Qualitative assessment of EE projects in Zimbabwe

On the supply side, ZESA has rehabilitated generation plant, to improve available capacity. The example discussed was upgrading Kariba South HPP, at a cost of US$40 million (1994 prices). This achieved 84MW of additional installed capacity, although available capacity increased by 190MW from 2000 to 2003. This project took place over a long period of time, but the generation availability increase is significant. The availability of funding is a key constraint for ZESA, and in the absence of donor funding they are exploring innovative ways of progressing generation rehabilitation. For example, ZESA and NamPower came to an agreement that NamPower would fund rehabilitation in exchange for generation capacity for a period of time.

[25] ZETDC; Non-technical loss reduction strategy document; 2nd Draft

On the demand side, ZESA has a number of planned projects, and these projects are typical of DSM projects seen in other SAPP countries; a CFL exchange programme, installation of prepaid meters and ripple control. The planned CFL exchange is budgeted to cost US$13 million (around US$7 million of which is on the CFLs), with expected savings of 120 – 180MW, and 50 GWh / month. However, it is important that the actual impact of this project is assessed. It is encouraging that a component of this project is for Measurement and Verification (M&V); ZESA has a budget for the M&V component and has written Terms of Reference to engage consultancy support. The planned timescale of the project is short; 3 months may be an unrealistic timescale. The installation of prepaid meters is expected to cost US$28 million, and achieve reductions in demand of around 10% or 150MW (given a maximum demand of around 1,500MW). Again, the planned timescale of the project is short, at 18 months to install 600,000 meters. The restoration and expansion of the ripple control system, at a cost of US$10.4 million, is expected by ZESA to shift up to 350MW of peak load. PPA Energy considers that this figure may be optimistic. ZESA believes that their Time of Use tariff has not been successful in influencing the load pattern of their MD customers.

The level of these potential energy shifts and savings due to planned DSM projects is high, but these are calculated figures. It remains to be seen how effective these measures will be.

As ZERA becomes established, it is important that it supports EE initiatives in its role as the regulator, e.g. in developing appropriate policy / standards.

There is currently no EE body in Zimbabwe.

5.6 South Africa

5.6.1 Stakeholders visited

PPA Energy was in Johannesburg between visits to the SAPP member countries that the SAPP-CC stipulated. The dates were Thursday 9th – Friday 10th February, and Wednesday 22nd – Friday 24th February. During this time, PPA Energy took the opportunity to visit the following organisations:

- Eskom (Eskom Distribution);
- The Renewable Energy and Energy Efficiency Partnership (REEEP);
- The National Energy Efficiency Agency (NEEA); and
- Enerweb.

PPA Energy also attended a WEC presentation, panel discussion and debate on “an assessment of national energy and climate policies in South Africa”,

hosted by the South African National Energy Association (SANEA) and ee publishers.

5.6.2 General

In 2007, South Africa started to experience an energy crisis; supply shortages led to rolling blackouts. This impacted both the domestic customers, as well as impacting the region, as many countries import from South Africa. A generation expansion plan was formulated to address the shortages in the medium to long term; in the short term, demand side initiatives were implemented.

There is considerable Energy Efficiency activity in South Africa, undertaken by a variety of partners. Some stakeholders expressed a concern that there may well be duplication in efforts and, at the policy debate, the Energy Intensive User Group stated that policy incoherence is a problem.

South Africa was not selected by the SAPP-CC for participation in this study, but PPA Energy took the opportunity to meet with key players. The following set of projects is not an exhaustive list of the EE activity in South Africa, but does capture some interesting and relevant experience.

5.6.3 Current Energy Efficiency Programmes

The current and proposed Energy Efficiency (EE) programmes that were discussed during the visit are summarised in the following table. More comprehensive information on each of the projects can be found in Appendix 4.

To put the figures below (e.g. costs and impact) into context, as of 2010 Eskom's maximum demand was 35,850 MW, sales were 218,591 GWh and annual revenue was US$9.9 billion.[26]

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
Smart Meter Pilot Project	Middle 2011	Eskom Distribution	80,000 smart meters	Not known	Delayed	Load shifting, ripple control

[26] SAPP Annual Report 2011

Project	Date started	Lead organisation	Scale	Cost	Timescale	Expected impact
PF correction penalty	July 2011	Eskom	4000 mining and industrial, 85,000 agricultural customers.	Not know	Proposals made in 2009	481 MW savings
Integrated Demand Management	2010 2013	Eskom Distribution	Not known	US$680 million over 3 years	3 years	1,072 MW and 4.1 TWh savings.
Virtual Power Station	2008	Enerweb	22 participants, 800MW of dispatchable load	US$2 / MWh for customers on standby, US$117 / MWh for dispatched customers		800 MW to supply shortages

Table 7: Summary of projects discussed in South Africa

5.6.3.1 Other Projects

As well as those summarised above, Eskom is also running an ongoing awareness campaign, a Power Alert and Performance Contracting; note that some of these are demand reduction / shifting initiatives rather than EE.

The awareness campaign includes education in schools and raising awareness of EE with all customers, through various media including TV, radio and newspapers. This is run by the Communications Department, and has a substantial budget.

The Power Alert is a dial which is shown on national television at peak times every evening. The dial indicates the capacity available; when the dial is in the red, viewers are asked to switch off non-essential load.

Figure 7. Power Alert on televisions

The Power Alert has been very successful; 400 MW of demand reductions are achieved within minutes. However, Eskom notes that they need to be careful not to "overdo" the use of it, as customers may become complacent. Note that this is a demand reduction, rather than an Energy Efficiency measure.

The Performance Contracting has been introduced recently, as Eskom did not believe they would meet the targets set for the Integrated Demand Management (IDM) programme. Eskom released a Request for Proposals for 30 GWh of savings over a 3 year period. They have allocated a number of contracts, which deliver turnkey projects to Eskom for energy reductions for 55 c/kWh between 6am – 10pm Monday to Friday, and at 10 c/kWh otherwise. The focus of the contract is on EE, so the kWh savings are linked to an output. Again, this is subject to Measurement and Verification.

Eskom was running an Energy Efficient Motor Programme as part of their DSM activities. This scheme has been stopped, as it was assessed as being ineffective. The lessons learnt from this scheme are that the use of EE motors needs to be well thought out; first, systems and processes need to be optimised; only then should the replacement of an original motor with an EE motor be considered.

5.6.4 Planned Projects

In discussions with Eskom it is understood that there have been proposals to improve the energy efficiency of the coal-fired power stations. As the majority of Eskom's generation is coal-fired plant (86%[27]), the potential for

[27] SAPP 2011 Annual Report

energy savings from this scheme is significant. The project would include introducing Variable Speed Drives (VSD) to optimise fans (on the stacks), pumps and the milling process; and considering the use of energy efficient motors. During the four-country visit it was understood that, due to generation capacity constraints in South Africa, the down-time required to fit and test these measures cannot be scheduled, as the generating units cannot be shut down for longer than the time required to perform statutory maintenance. However, information has since been provided on a "quick wins" review that is being undertaken on 13 coal-fired power stations. The aim of the review is to identify opportunities and undertake corrective actions to improve thermal efficiency and generation capacity performance. The programme is due to complete by the end of 2015. Full information on this project, which was provided by Eskom, can be found in Appendix 4.

5.7 Regional Energy Efficiency

As part of the Windhoek meetings, PPA Energy met with the Regional Electricity Regulators Association of Southern Africa (RERA) RERA stressed the importance of Regulators and Ministries in setting policy and regulations to support Energy Efficiency measures. The example of the EU was cited, where targets are set for each country and action plans developed. RERA considers that the challenges in the SAPP region are:

- At the regional level, the "right approach" to EE has not been achieved; and
- Not all critical players are recognised in the EE arena.

An example of a RERA-led project is the development of guidelines for cross-border trading. The guidelines were drafted for consultation with all stakeholders, finalised in 2010, submitted to SADC ministries, and are being adopted as SADC guidelines. Five out of nine RERA members have formally submitted the guidelines to their respective ministries for approval. This is a good example of the process that can be followed to raise issues at the ministry level, and ensure stakeholder support. As well as lobbying ministries, regulators also have a key role to play in tariff approval and setting, as tariffs can be used to incentivise utilities to perform in certain areas.

In RERA's view, the areas for significant gain in EE across the region include tackling distribution losses, encouraging co-generation and cost reflective / ToU tariffs. Regulators could raise the awareness at ministry level of the drawbacks and consequences of tariffs that are below cost levels.

RERA currently has a project for which they are seeking funding, to understand how regulators can incentivise EE.

5.8 Overall Assessment of Energy Efficiency Projects in SAPP

5.8.1 Summary of current projects

A summary of the projects (currently implemented and planned) discussed in each of the nominated countries, is shown in the table below.

Project	Namibia	Zambia	Tanzania	Zimbabwe
CFL exchange programme	✓	✓	✓	✓
Energy Saving / Awareness Campaign	✓	✓	✓	
Demand Market Participation	✓			
Time of use tariff	✓	✓		✓
Ripple Control	✓			✓
SOLTRAIN / SWH project	✓	✓		
EE Programme in Buildings	✓			
EE Audits	✓	✓		
Installation of prepaid meters		✓		✓
Generation Rehabilitation	✓	✓	✓	✓
Transmission line upgrade		✓	✓	✓
Power Factor Correction	✓	✓	✓	
Distribution loss reduction		✓	✓	✓
Standards and product labelling		✓	✓	

Table 8: Summary of current projects discussed

5.8.2 Key observations

The key observations from the review of current and planned EE and DSM projects in the SAPP countries visited are as follows:

- The initiatives are driven by regional capacity shortages, which commenced in 2007. The severity of the impact of the shortages varies; for example, in Namibia there is fear of load-shedding which is driving the

initiatives, whereas in Zimbabwe residential load shedding takes place every day at peak time.

- The countries are at different stages of implementing EE projects. For example, in Namibia there has been appreciable activity, undertaken by a variety of stakeholders, and NamPower has been funding its initiatives. Whereas in Tanzania, although there have been useful studies undertaken by DECON and Hatch, there has been very little actual implementation of EE measures.

- The focus of activity so far has been on demand side measures, and this is, in part, attributable to the Demand Side Management Working Group established by SAPP. Typical DSM initiatives include CFL exchange programmes, the introduction of ToU tariffs, ripple control and the installation of prepaid meters.

- Some activity in Energy Efficiency has been seen on the supply side; mainly the improvement of generation efficiency by rehabilitating plant. Examples of this can be seen in Zambia, where 10-20% increases in capacity have been realised. CEC has focussed on supply side measures, with power factor improvement on the network expected to result in additional capacity in excess of 80 MVA of capacity, which is around 10% of CEC's peak demand.

- It is encouraging that initiatives are underway in some SAPP countries. However, a key concern is that the impact of individual projects is not known, making it impossible to evaluate their effectiveness. Measurement and Verification of individual initiatives has been difficult due to the many initiatives undertaken simultaneously.

- It is important to note that there is a role for all stakeholders in developing and implementing sustainable EE projects, not just utilities. For example, Regulators can play a role by incentivising efficiency in various functions of utilities and by developing or adopting standards, and government departments can ban inefficient technologies. The role that SAPP can play needs to be carefully considered.

- All stakeholders that were engaged with as part of this study have been very supportive of the aims of the project.

6 Evaluation and Prioritisation of Projects for Implementation

6.1 Method

The following method has been applied to undertake an evaluation of EE projects:

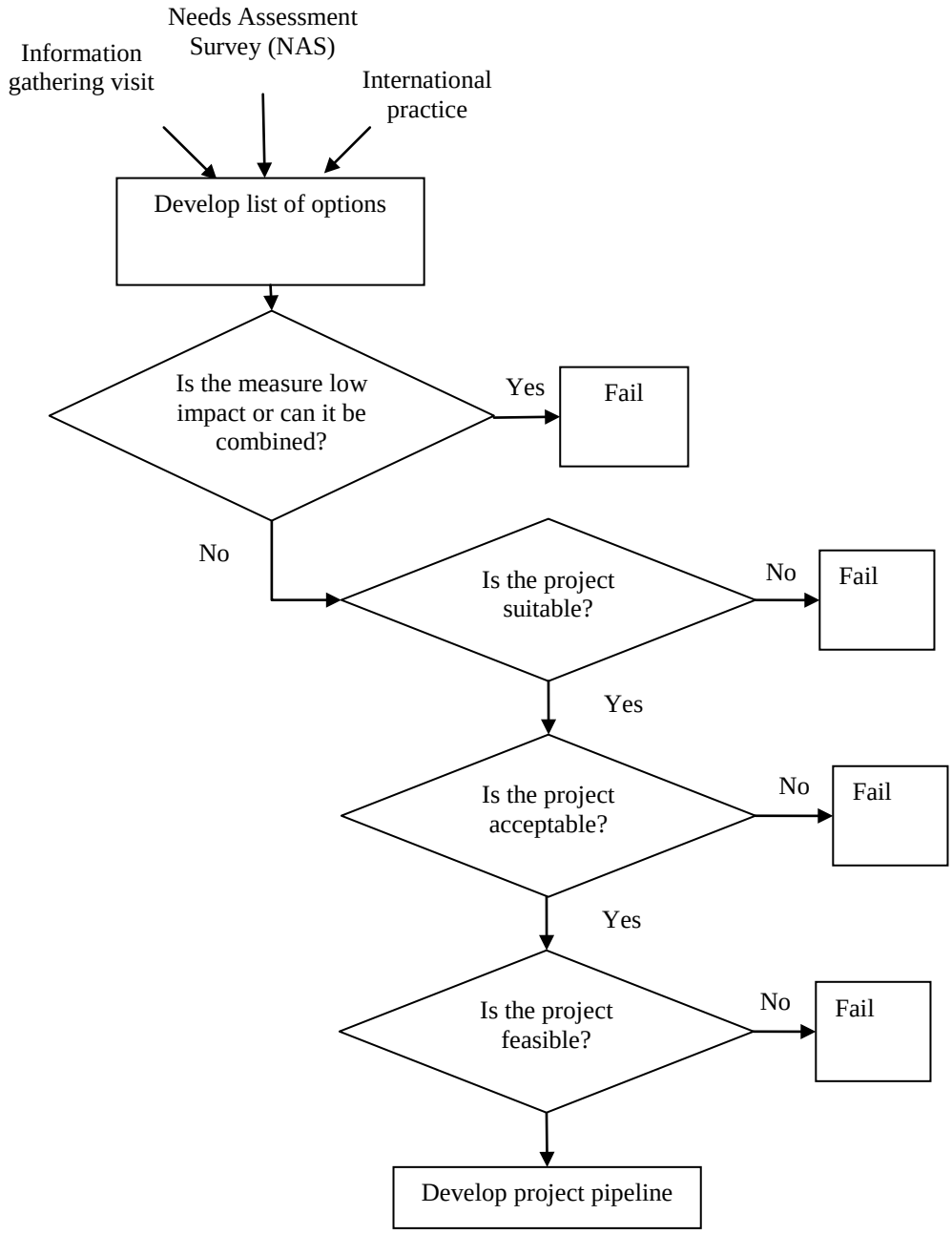


Figure 8: Evaluation method

A system of filtering the population of options has been adopted. The input is the range of options. The output is the same set of options categorised into:

- Recommended;
- Marginal; or
- Rejected.

Following the evaluation of projects, they have been prioritised. This evaluation and prioritisation was subject to discussion by SAPP at the first workshop. At each step in the process, the option may be categorised as:

- Pass;
- Marginal; or
- Fail.

Options that Pass on any step will remain on the same level as either Recommended or Marginal. Any option assessed as Fail will be moved to the Rejected category. It is only possible to revert from Marginal to Pass or from Fail to Marginal status if external circumstances are changed or if stakeholder input points to some relevant reasons that alters the evaluation.

The evaluation criteria (suitability, acceptability, feasibility) are explained and expanded below.

It should be noted that the evaluation stage spans several separate tasks itemised in the Terms of Reference.

6.1.1 Evaluation Criteria

The evaluation criteria used in this study are as follows:

- **Suitability**, i.e. does the measure meet the requirements of SAPP in terms of the following:
    - Energy Efficiency – Does it address the aims of the study, of being an energy efficiency measure to delay capital intensive investment?
    - Impact - Is it a high impact project for energy efficiency in the SAPP region?
    - Timescale - Can it be implemented in the short (0-2 years) to medium term (2-5 years)?

- Role for SAPP – Is there a suitable role and a mandate for SAPP to play in co-ordinating the project?

- Regional – Is the project suitable for regional implementation, rather than being appropriate for only a minority of SAPP member countries?

- **Acceptability**, i.e. are the consequences of the EE intervention acceptable to the stakeholders, including:

  - Utilities

  - Customers

  - General Public

  - Government

  - Donor community; interests include poverty alleviation, economic growth and climate change.

  - Regulator, a key function of which is to protect the interests of customers (both existing and aspiring). Note that while the Regulator is a key stakeholder, as they either represent the views of customers (if they are independent from government) or government (if they are not independent from government), the views of the Regulator are represented in these two stakeholder categories.

- **Feasibility**, i.e. is it achievable in resource terms (e.g. can it readily be funded); does it have an internal rate of return that exceeds a reasonable hurdle rate (typically 10%)? Economic analysis and discounted cash flow are used with a discount rate set at a nominal 10%. Initially, the benefit stream of each project will be restricted to benefits that are readily quantified, e.g. using Long Run Marginal Costs (LRMC) as a proxy for end user benefits.

6.2 Original List of Projects

Potential Energy Efficiency projects have been identified through several means:

- International practice in Energy Efficiency;

- Discussions with stakeholders during the four-country visit; and

- Suggestions from SAPP members via the Needs Assessment survey.

This list of projects is shown below. The customer groups involved or functional areas for each project are indicated.

EE and Load-shifting measure	SO, planning, trading	Generation	Transmission	Distribution and supply	Industrial	Commercial	Residential	Regulation, policy standards, tariffs	Education and information dissemination
	Supply-side				Demand-side			Other	
Optimise generation dispatch	✓	✓							
Optimise energy trading in SAPP	✓								
Regional trading of "NegaWatts"[28]	✓				✓				
Demand response for peak lopping					✓				
Regional Integrated Resource Plan (IRP) (least cost development plan)	✓								
Generation rehabilitation		✓							
Encourage local co-generation (CHP)		✓			✓	✓			
Transmission system loss reduction - technical			✓						
Transmission system loss reduction – non-technical			✓						
Distribution system loss reduction – technical				✓					
Distribution system loss reduction – non-technical				✓					

[28] "Negawatts", short for negative watts, means a reduction in demand, typically at peak times, as an incentivised alternative to increasing generation to meet demand

EE and Load-shifting measure	SO, planning, trading	Generation	Transmission	Distribution and supply	Industrial	Commercial	Residential	Regulation, policy standards, tariffs	Education and information dissemination
Power factor correction			✓	✓	✓				
Energy Efficiency Obligation				✓					
Meter projects (Smart meters, Automated Meter Reading, Prepayment meters, improve meter coverage)				✓	✓	✓	✓		
Review tariff structure – cost reflective								✓	
Report KPIs and set targets	✓	✓	✓	✓				✓	
Minimum standards of equipment efficiency		✓	✓	✓	✓	✓	✓	✓	
National EE programmes with quantitative targets		✓	✓	✓				✓	
EE lighting regulations					✓	✓	✓	✓	
Improve building insulation / glazing (building standards)					✓	✓	✓	✓	
Energy label programmes					✓	✓	✓	✓	
ToU tariffs					✓			✓	
EE lighting					✓	✓	✓		
EE household refrigerator programme							✓		
Refrigerated beverage vending machine programme					✓	✓			
Solar Water Heating and heat pump programme					✓	✓	✓		
Distributed generation (e.g.					✓	✓	✓		

EE and Load-shifting measure	SO, planning, trading	Generation	Transmission	Distribution and supply	Industrial	Commercial	Residential	Regulation, policy standards, tariffs	Education and information dissemination
PV)									
Motor change-out programme					✓				
More efficient cooling (air conditioning)						✓	✓		
Provision of operating reserves and balancing services by energy intensive industries	✓				✓				
Demand response for peak lopping	✓				✓				
Energy audits					✓	✓			
Capacity building in implementing, monitoring and evaluating EE projects									✓
Sharing best practice (in loss reduction / EE)									✓
Public awareness campaign					✓	✓	✓		✓

Table 9. Original list of options

6.3 Initial Filter of Projects

An initial filter of the projects detailed in the previous sub-section was applied before proceeding to the detailed project evaluation, based on a number of criteria, including:

- Low impact; and
- Potential to be combined with another measure.

In the initial phase of work, projects that were considered to be load-shifting rather than EE, were removed at this initial filter stage. Following a request at the first workshop that load-shifting projects be considered, these projects have now passed the initial filter of projects.

A summary of projects failing this initial filter is presented below, together with the reasons for reaching this conclusion.

EE or load-shifting measure failing initial filter	**Comment**	**Outcome**
Regional Integrated Resource Plan (IRP) (least cost development plan)	SAPP already undertakes this exercise.	Not considered for evaluation.
Encourage local co-generation	This project could be combined with either an EE audit, or an awareness campaign.	Combine with EE audit or awareness campaign.
Transmission system loss reduction – technical and non-technical	Published data[29] shows that transmission losses in SAPP are generally at or below levels seen internationally. In addition SAPP members indicated during the 4-country visit that losses at the transmission level are not significant, and this does not represent an area for potential savings.	Low impact project – not considered for evaluation.
EE household refrigerator programme	Data for Namibia[30] and Zimbabwe[31] shows that refrigeration accounts for a small portion of domestic energy use. The main contributors are electric water heating, space heating and lighting. It is not considered that, throughout the SAPP region, this is an area for	Low impact project – not considered for evaluation.

[29] RERA publication on Electricity Tariffs and Selected Performance Indicators for the SADC Region 2009

[30] EMCON Consulting Group for ECB; Demand Side Management Study for Namibia; 2006

[31] AEE Institute for Sustainable Technologies; Southern African Solar Thermal Training and Demonstration Initiative "SOLTRAIN": First progress report, part 4; 2010

EE or load-shifting measure failing initial filter	Comment	Outcome
	significant potential savings.	
Refrigerated beverage vending machine programme	This could form part of a recommendation as part of an EE audit.	Combine with EE audit.
Motor change-out programme	This could form part of a recommendation as part of an EE audit. Process optimisation ought to be employed before considering the roll-out of a motor change-out programme, so this project should be a secondary priority to EE audits.	Combine with EE audit.
More efficient cooling (air conditioning)	This could form part of a recommendation as part of an EE audit.	Combine with EE audit.
Sharing best practice (in loss reduction / EE)	This should form part of the loss reduction project.	Combine with loss reduction.

Table 10. Filtering of original list

In addition to the above, projects that fall under regulation, policy, standards and tariffs are considered to be under the remit of either Regulators or government energy departments. They are included in the original list for completeness, as they are key in supporting projects that could be co-ordinated by SAPP and implemented by utilities. They are not being considered further at this stage, except for those that had express support from SAPP members in the Needs Assessment survey.

6.4 Revised List of Projects

Following the application of the initial filter, the projects that proceed to the evaluation stage are as follows:

Reference number	Project
01	Optimise generation dispatch
02	Optimise energy trading in SAPP
03	Generation rehabilitation
04	Distribution system loss reduction – technical and non-technical
05	Energy Efficiency Obligation
06	Meter projects (Smart meters, Automated Meter Reading, Prepayment meters, improve meter coverage)
07	Energy Efficient lighting
08	Solar hot water and heat pump programme – capacity building
09	Provision of operating reserves and balancing services by energy intensive industries
10	Energy audits
11	Capacity building in measurement and verification of EE projects
12	Public awareness campaign
13	Tariff setting principles
14	National Energy Efficiency programmes with quantitative target
15	Energy Efficient lighting regulation
16	Regional trading of Negawatts
17	Time of Use tariffs
18	Demand response for peak lopping

Table 11: Revised list of projects

Option 15 Energy Efficient lighting regulation was considered in the draft report, due to the support this option received from SAPP members in the Needs Assessment Survey. It is understood from the first workshop that this project is already under implementation; SAPP is developing CFL standards. SAPP therefore requested at the first workshop that this option be removed from this analysis. The project is included in the above table to maintain consistency in project numbering between versions of the report and workshops.

6.5 Evaluation of Projects

The following section presents a summary of the project evaluations against the criteria described in 6.1.1. The full project background, descriptions and evaluations are contained in Appendix 5.

A "traffic light" system has been used to illustrate the project evaluation:

- Green represents a pass;
- Orange represents a marginal pass; and
- Red represents a fail.

The assessment of each project as a pass, marginal or fail was in general qualitative, and as such relatively subjective. In view of this, the evaluations were discussed at both workshops, and have been revised to take account of feedback from SAPP members.

6.5.1 Optimise generation dispatch (Option 01)

Description of Project

Optimising hydro and thermal power plant dispatch in the SAPP interconnected system, to ensure that power stations are run in an optimal manner.

The avoidance of water spillage at hydro stations can result in direct energy savings at other power stations – hydro or thermal – in the system (or reduction of load shedding). At the time of the meetings with the four SAPP-nominated countries there were hydro dams that were spilling water due to the abundant rains. A study has been undertaken in the Zambezi River Basin on dam synchronisation; recommendations include capacity building in reservoir synchronisation and flow forecasting models.[32]

[32] Transboundary Water Management; Dam synchronisation and flood releases in the Zambezi River Basin Project; March 2011

Project Evaluation

Suitability	Although this meets SAPP's requirements in terms of Energy Efficiency the full impact cannot be analysed without more information being provided by the utilities. This project is **marginal** on these suitability criteria.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. The project **passes** on this criterion.
Feasibility	The hydro and constrained dispatch routines exist in the region and the costs to implement a constrained dispatch should be minimal. Sufficient information has not been provided to determine the potential energy savings. SAPP could launch a research project to determine regional energy savings.

6.5.2 Optimise energy trading in SAPP (Option 02)

Description of Project

Optimise dispatch through vibrant market interaction between the member utilities and other trading members. The day-ahead market platform will need to be extended. Real-time information is available on the new SAPP SCADA system and congestion can be calculated in real-time.

Project Evaluation

Suitability	Although this meets SAPP's requirements in terms of Energy Efficiency the full impact cannot be analysed without more information being provided by the utilities and SAPP trading members. This project is **marginal** on these suitability criteria.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. The project **passes** on this criterion.
Feasibility	The costs for a trading platform would be dependent on the complexity of the trading rules that would apply, and are estimated to be in the order of US$10 million. The potential benefits need to be determined, which could be a topic for SAPP driven research. SAPP did state that it

	is already capable of determining congestion in real time with the new SCADA system. The costs and benefits of relaying this information to potential trading members needs to be analysed.

6.5.3 Generation rehabilitation (Option 03a) – Hydro plant

Description of Project

Rehabilitation of hydro generating plant in order to improve generation efficiency, i.e. increase the energy produced for the same water intake. Rehabilitation measures can include civil works (e.g. repair tunnels and shafts, removal of sediment deposits, removal of aquatic reeds) and electromechanical rehabilitation (e.g. refurbish turbines, valves and generators, replace transformers). Rehabilitation projects can result in the restoration of hydro plant to their original capacity or even a slightly higher capacity than in the original.

SAPP could co-ordinate a study to identify improvements that could be made to interconnected SAPP hydro generation.

Project Evaluation

Suitability	This meets SAPP's requirements in terms of Energy Efficiency and impact (rehabilitation projects undertaken by SAPP members have resulted in 10-20% increases in generation capacity). Although, the timescales for rehabilitation projects (in the order of several years, e.g. in Zambia 4 – 10 years) may fall outside of the range in SAPP's interest, in this case, this project has been assessed as marginal so that the project can proceed, for discussion. This project is **marginal** on these criteria.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. The project is a **pass** on this criterion.
Feasibility	NPV results for hydro rehabilitation show a Net Present Value of US$435 million with an IRR of 35%. SAPP could co-ordinate a study on generation efficiency improvements that could be made to interconnected SAPP hydro generation. A technical team would visit hydro power plant, where making efficiency improvements may be appropriate, to identify where improvements can be made. The cost of visits to 10

	power stations is estimated at US$420,000, with the study taking around 10 months.

6.5.4 Generation rehabilitation (Option 03b) – Coal plant

Description of project

Refurbish or upgrade coal-fired generating plant in order to improve generation efficiency and decrease auxiliary consumption, i.e. increase the electricity produced for the same fuel consumption. Measures taken to improve efficiency can be minor or major. Minor measures can include upgrading control systems, reduction of steam side losses and combustion tuning. Major measures can include upgrading boilers and turbine blades, coal mill replacement and cooling tower optimisation. Parts of the plant can be refurbished, replaced or upgraded when replaced, and operation and maintenance practices can be improved.

A key measure for reducing auxiliary consumption is to replace existing motors with properly sized and/or energy efficient motors, as most auxiliary loads are powered by electric motor drives (e.g. feed-water system, cooling water system). Variable-speed drives can also be used for large fans and pumps.

Project Evaluation

Suitability	This meets SAPP's requirements in terms of Energy Efficiency and impact. However, the timescales for rehabilitation projects may fall outside of the range in SAPP's interest, in this case, and as some SAPP countries have no coal-fired power stations, this measure is not relevant to all. This project is **marginal** on these criteria.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. The project is a **pass** on this criterion.
Feasibility	The cost associated with rehabilitating 25% of the installed coal capacity in SAPP (excluding South Africa) is estimated at US$46 million. As a first step, SAPP could co-ordinate a study on least-cost short-term generation efficiency improvements that could be made to interconnected SAPP coal-fired generation ("quick wins"). The cost of technical visits to 5 power stations is estimated at US$210,000, with the

	study taking around 5 months.

6.5.5 Distribution Loss Reduction (Option 04)

Description of Project

A project to identify measures to reduce losses, both technical and non-technical, in distribution networks. The project would comprise the following stages:

- Conduct a survey to establish distribution loss levels, technical and non-technical, and to identify the primary causes;
- Identify potential solutions – at this point technical and non-technical loss reduction will become two separate strands, as the measures to address each are of a different nature; and
- Where the utilities implement the recommended measures, monitor progress and loss levels to assess impact of loss reduction measures.

Project Evaluation

Suitability	Technical and non-technical loss reduction projects meet all of the criteria for suitability, and therefore **pass** this stage of assessment.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project, except for those who are benefiting from electricity theft or fraud. The project is a **pass** on this criterion.
Feasibility	The aim of the loss reduction survey is to identify economic measures for loss reduction. It is difficult to estimate the cost for a loss reduction survey, as this will depend on factors in each country. An estimate for a loss reduction survey to identify the level of losses and primary causes and recommend a list of measures for implementation is US$300,000 per country.

6.5.6 Energy Efficiency Obligations (Option 05)

Description of project

An Energy Efficiency Obligation (or Energy Saving Obligation) is **a legal obligation placed on electricity suppliers / retailers or Distribution Network Operators to meet an energy saving target (e.g. in the form of a number of GWh per year) by eligible measures**. There is a formal monitoring and verification process to ensure that targets are met; penalties can be applied where targets are not met. The aim of the Obligation is to promote and stimulate investment to save energy in consumers' premises.

Project Evaluation

Suitability	The scheme could be defined to meet the EE criteria, the potential impact is high and it is a short-term policy measure. If legislation is required this could take the measure outside of SAPP's scope, and introduce delays, but the measure need not be legislated. SAPP could help to inform discussions and develop the details of the obligations. This project is considered to be **marginal** on the suitability criteria.
Acceptability	This measure is likely to appeal to governments, as public funding is not required, and the impact on consumer bills is modest. However, at a time when electricity prices are increasing in SAPP countries, which is meeting resistance from customers, even this modest increase could be considered unacceptable. This project is, therefore, considered to be **marginal** in terms of acceptability.
Feasibility	The NPV and IRR figures suggest this is an economic measure. It should be noted that this could be an effective measure for capturing all demand-side EE projects – the party(s) responsible for meeting the target (Distribution Network Operator or retail) should find the most cost effective and fast-acting customer side measures, as it is in their interests to do so.

6.5.7 Meter projects (Smart meters, Automated Meter Reading, Prepayment meters, improve meter coverage) (Option 06)

Description of project

A Pilot Project for Smart Meters in order to inform discussion on a potential rollout in SAPP countries. Smart Metering does not only comprise the meters themselves: it is a system of meters; a communications layer for the two-way communication and data transfer between the consumer and the supplier; and an IT system to manage the data and services. A pilot project could involve the following in a nominated SAPP member country:

- Consideration of the technical design of the Smart Meter system;
- A pilot of Smart Meters to a sample of customers, and the associated infrastructure;
- An assessment of the technology (above);
- An assessment of customer behaviour; and
- An assessment of the feasibility of Smart Meters in the SAPP region, including cost-benefit analysis of a Smart Meter Rollout.

This would aid discussions on the potential usage or roll-out of Smart Meters in SAPP countries.

Project Evaluation

Suitability	Overall this project is considered to be **marginal** in terms of suitability. While there is potential for Smart Meters to have an impact on customer behaviour when paired with other initiatives, this may not be suitable for all SAPP member countries at this point in time, due to potential conflict with current metering programmes and typically low consumption in member countries.
Acceptability	Overall this project is considered as **marginal** in terms of acceptability. Depending on the tariff regulation arrangements, customers may have to cover the costs of a smart meter programme. The donor community may have concerns about low impact.
Feasibility	For most countries, the analysis shows a positive NPV with IRR greater than 10%. The exceptions are Lesotho, Malawi and Mozambique, where the combination of low LRMC and low residential consumption do not make this measure an attractive option at present. As this project is not suitable for all SAPP countries (i.e. those where high-usage residential demand is relatively low), this project is considered to be **marginal** on the

	feasibility criterion.

6.5.8 Energy Efficient Lighting (Option 07)

As the promotion and exchange of EE light bulbs already has significant focus in SAPP member countries, it would appear that there is a limited role for the SAPP-CC to play here. Where the SAPP-CC could play a role is in the supporting measures required around the distribution of low energy light bulbs; supporting legislation, regulations and standards. This was originally considered as Option #15, which has been removed from the project evaluations as it is already being implemented.

The assessment of this project was supported by SAPP members at the first workshop; as SAPP has already championed a specification for CFLs, a further role for SAPP does not need to be considered at this time. However, it is noted from workshop discussions that SAPP working groups need to keep informed on developments in technology, e.g. new types of energy efficient lighting.

6.5.9 Solar Water Heater programme (Option 08)

Description of project

Capacity building in Solar Water Heating (and Heat Pump) design, production, installation, implementation and maintenance to facilitate the roll-out of Solar Water Heaters to residential customers. Based on the SOLTRAIN model[33], and experience from South Africa, components of this project could include:

- Undertaking country studies to obtain detailed knowledge of SWH deployment in each country (these studies could include a review of the forms by which SWH is promoted in the region, and elsewhere, e.g. loans, grants, feed-in tariffs, tax-free status, etc.);
- Running training courses in the design, production, installation, implementation and monitoring of SWH systems (e.g. periodic certified training courses for qualified plumbers in the installation of SWH);
- Monitoring of impact in terms of energy reductions, product quality, installation quality and training quality

[33] SOLTRAIN summary of 2nd Progress Report

- Supporting political decision makers with information on potentially successful support mechanisms; and

- Public awareness campaigns.

Project Evaluation

Suitability	Overall this project is considered to be **marginal**. While some SAPP utilities are planning SWH programmes, which would benefit from capacity building in the installation of SWH, this is not directly relevant to SAPP member utilities. This project may be more suited to being co-ordinated by other agencies rather than SAPP.
Acceptability	It was agreed at the first workshop that the assessment against the acceptability criteria would be revised to **marginal** (from pass), as the role for SAPP is questionable.
Feasibility	The NPV results are negative for several SAPP countries. The cost benefit analysis shows that while the roll-out of SWH in high-usage residential customers is a favourable measure to consider for most SAPP countries, it may not be suitable for all.

6.5.10 Provision of operating reserves and balancing services by energy intensive industries (Option 09)

Description of Project

Identification of consumers prepared to reduce consumption for the provision of operating reserves and balancing, where such consumers will either save energy consumed or provide increased generation production / efficiency.

Project Evaluation

Suitability	Although this meets SAPP's requirements in terms of Energy Efficiency for some consumers, there is no involvement foreseen for SAPP and this is not a regional project. This project is a **fail** on these criteria. This assessment was supported by SAPP members at the first workshop.

Acceptability	
Feasibility	

6.5.11 Energy Audits for Large Customers (Option 10)

Description of project

Produce a number of case studies on best practice energy efficiency audits for different types of industrial consumer and disseminate the information. The specific proposal, here, is for SAPP to assist with the writing-up of best practice cases from previously conducted and ongoing energy audits and energy management initiatives in the region. The case studies could cover a number of types of industrial and large customer, such as mining, mineral smelting, manufacturing, airport terminals, shopping malls and other retail outlets.

Project Evaluation

Suitability	Although most areas pass on the suitability criteria, it was agreed at the first workshop that the assessment of this project should be revised to **marginal** (from pass), as there is not a strong case for a role for SAPP.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project, but it may not be attractive to the donor community. Therefore overall this project is considered to be **marginal** in terms of acceptability.
Feasibility	For the majority of SAPP countries the NPV for EE audits is positive with an IRR just above 10%. In some cases, where LRMC and/or industrial consumption is low, the NPV is negative. In total it is estimated that writing-up and disseminating case studies would cost SAPP US$100,000.

6.5.12 Capacity building in measurement and verification of EE projects (Option 11)

Description of project

Capacity building in Measurement and Verification for Energy Efficiency projects. This will enable those taking part in training to plan, set up and

maintain appropriate Measurement and Verification (M&V) approaches for a variety of EE projects. M&V is "the process of using measurement to reliably determine actual savings created within an individual facility by an energy management program".[34] It provides impartial quantification of impacts and savings.

Project Evaluation

Suitability	Overall, although not directly resulting in energy efficiency savings, this project is considered to meet SAPP's criteria, and to be an important facilitator for implementing the other EE projects in the programme. This project is a **pass** on the suitability criteria.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. The project **passes** on this criterion.
Feasibility	Costs can be estimated based on training that is already available - this comes to around US$3,200 per person. For example, if SAPP were to obtain funding for three people from each SAPP utility to attend training (excluding South Africa, where NERSA conducts M&V training) this would cost around US$115,000.

The assessment of this project against the three criteria was supported by SAPP members at the first workshop. In particular, SAPP members agreed that this should be a high priority project, in facilitating other EE and load-shifting projects.

6.5.13 Public Awareness Campaign (Option 12)

Description of project

Acting as a central body to gather campaign material from, and share campaign material with, SAPP members, for them to make use of in their own marketing campaigns. SAPP would be providing and maintaining a library for campaign material. It was noted during the second workshop that the library could also be used for SAPP members to share "success stories" of energy efficiency projects.

[34] International Performance Measurement and Verification Protocol; Efficiency Valuation Organisation (EVO); January 2012

Project Evaluation

Suitability	Overall this project is considered to meet SAPP's criteria. As with the capacity building, this is considered to be an important measure in supporting the other EE projects in the programme. This project is a **pass** on the suitability criteria.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. This project is considered to **pass** on this criterion.
Feasibility	Running costs for the library are estimated to be US$16,000 per year. This includes estimated costs of suitable IT tools and some personnel time. It is noted that cost information for running a full campaign was provided by NamPower during the four-country visit. The annual cost, during a relatively high-spend year, was 2 million Namibian dollars, which is around US$240,000. This is 0.08% of NamPower's revenue, according to the SAPP 2011 Annual Report.

6.5.14 Tariff Setting Principles (Option 13)

Description of project

SAPP, working together with RERA, should develop and disseminate tariff setting principles. This would help to raise awareness of tariff approval at the country level, as well as giving guidelines on setting tariffs to be cost reflective (cost recovery is a key principle of tariff setting). Full costs of a utility in providing electricity include efficient operating costs, as well as a return on assets needed to provide supply and invest to meet future demands. These costs need to be reflected in tariff levels in order for the utility to be financially sustainable.

Project Evaluation

Suitability	This measure is a pass against each suitability criterion, and is considered to **pass** the suitability criteria.
Acceptability	Cost reflective pricing is key in supporting EE initiatives. By producing a set of tariff setting principles this project allows SAPP and RERA to publicise the benefits of cost-reflective pricing, while allowing each

	individual SAPP country to work towards cost reflective pricing at their own pace. It was agreed at the second workshop that this assessment against the acceptability criteria would be revised to **pass** (from marginal), due to the support for the principles of this project.
Feasibility	The costs of such a project are estimated at US$100,000-150,000.

There was strong support from SAPP members for the above project at both workshops.

6.5.15 National Energy Efficiency Plans with quantitative targets (Option 14)

Description of project

National Energy Efficiency Plans, to be produced by each SAPP country, setting quantitative targets for energy efficiency improvements or energy savings. A National Energy Efficiency Plan has two key components:

- Setting an energy saving (or energy efficiency improvement) target; and
- Proposing concrete measures and actions that contribute towards meeting the target.

Project Evaluation

Suitability	National Energy Efficiency Plans are in the remit of government, and outside of SAPP's scope of activity. Whilst SAPP could provide an advisory role, this is considered to be outside of their scope. This project **fails** on suitability. This assessment was supported by SAPP members at the first workshop.
Acceptability	
Feasibility	

6.5.16 Energy Efficient Lighting Regulation (Option 15)

As discussed in Section 6.4, this project has been removed from the project evaluations following the first workshop, as it is understood that this project is already under implementation.

6.5.17 Regional trading of Negawatts (Option 16)

Description of project

Negawatts, which is short for negative watts, means a reduction in demand in exchange for a payment, typically at peak times, as an alternative to increasing generation to meet demand. The proposed project is **a regional aggregated demand response (negawatts) platform, which operates within existing SAPP markets.** The platform will allow demand customers to bid into the market to reduce their demand for a given price during set time periods. Buyers could purchase a reduction in demand, rather than an increase in generation. It was noted at the second workshop that as a first step on this project SAPP would need to develop a framework to allow such a platform to move forwards.

Project Evaluation

Suitability	It was agreed at the second workshop that the assessment against the suitability criteria would be revised to **marginal** (from pass) as the estimated impact, based on experience in South Africa, is not as high as other projects that have been evaluated.
Acceptability	It is unlikely that any of the stakeholder groups considered in this study will be negatively affected by this project. It is considered to **pass** in terms of acceptability.
Feasibility	The costs associated with developing and running such a platform would need to be determined more accurately for the SAPP region, in a dedicated study. Alternatively, if the data aggregator becomes a SAPP member they would include development costs in their bids and offers. The costs are likely to be small compared with the potential savings (in terms of reducing unserved energy and the costs associated with it). The project is considered a **pass** on the feasibility criterion.

6.5.18 Time of Use tariffs (Option 17)

It is suggested that Time of Use tariffs would be considered in either or both of the following projects:

- Option 06 Smart Meter Pilot Programme: The CER (Commission for Energy Regulation, the Regulator in Ireland) Smart Meter pilot programme investigated the effectiveness of Smart Meters in combination with other DSM measures, such as ToU tariffs. The effectiveness of ToU tariffs in the SAPP region could be studied as part of the Smart Meter pilot project.

- Option 13 Review tariff structures: When SAPP and RERA are developing principles for tariff setting, the application of ToU tariffs may be considered, particularly for large customers.

This measure is therefore not considered as a stand-alone project.

6.5.19 Demand response for peak lopping (Option 18)

Demand reduction over peak aims to reduce the number of un-served customers in countries where there is insufficient generating capacity to meet the peak demand, or to reduce expensive generation in countries where there is sufficient capacity.

One method to encourage peak lopping is to introduce time-of-use-tariffs in which the consumer is charged a high price for consuming in peak hours. This option is already addressed in:

- Option 06 Smart Meter Pilot Programme: The CER Smart Meter pilot programme investigated the effectiveness of Smart Meters in combination with other DSM measures, such as ToU tariffs. The effectiveness of ToU tariffs in the SAPP region could be studied as part of the Smart Meter pilot project.

- Option 13 Review tariff structures: When SAPP and RERA are developing principles for tariff setting, the application of ToU tariffs may be considered, particularly for large customers.

The second method is to compensate consumers to reduce their demand. This option is already addressed in:

- Option 09 Provision of operating reserves and balancing services by energy intensive industries: The reduction in demand can be provided as an operating reserve and only used when the need arises.

- Option 16 Regional trading of Negawatts: Consumers, through their host TSO's, can offer to reduce their consumption through an

aggregator who then sells consumption reductions bilaterally or trades on DAM.

A third option is to encourage consumers to reduce demand in peak through advertising campaigns.

- Option 12 Public Awareness Campaign: The reduction in consumption over peak is addressed through advertising and educating consumers not to waste energy when the network is under stress.

Peak lopping is not considered as a stand-alone option; all the facets of peak lopping are addressed in other options.

6.6 Summary of Project Evaluation

The following table summarises the results of the project evaluation stages.

Ref. No.	Project	Suitability	Acceptability	Feasibility	Overall
01	Generation dispatch	Marginal	Pass	[35]	Marginal
02	Energy trading in SAPP	Marginal	Pass	As above	Marginal
03a	Hydro rehabilitation	Marginal	Pass	Pass	Marginal
03b	Coal rehabilitation	Marginal	Pass	Pass	Marginal
04	Distribution losses	Pass	Pass	Pass	Pass
05	EEO	Marginal	Marginal	Pass	Marginal
06	Smart Meter	Marginal	Marginal	Marginal	Marginal
07	EE lighting	Fail			Fail

[35] Not sufficient information provided to determine feasibility. Assessing the potential value could be a SAPP driven research project.

Ref. No.	Project	Suitability	Acceptability	Feasibility	Overall
08	SWH capacity building	Marginal	Marginal	Marginal	Marginal
09	Operating reserves	Fail			Fail
10	Energy audits	Marginal	Marginal	Marginal	Marginal
11	M&V	Pass	Pass	Pass	Pass
12	Awareness campaign (library)	Pass	Pass	Pass	Pass
13	Tariff principles	Pass	Pass	Pass	Pass
14	NEEAP	Fail			Fail
15	EE lighting regulation	Not required to evaluate.			
16	Regional negawatts	Marginal	Pass	Pass	Marginal
17	ToU tariff	Not evaluated as a stand-alone project.			
18	Demand response	Not evaluated as a stand-alone project.			

Table 12. Summary of project evaluations

6.7 Project Prioritisation and Pipeline

The aim of this sub-section of the report is to prioritise the options that have been outlined and evaluated above. Also, drawing from this prioritisation, this sub-section advances an indicative project pipeline, together with possible timescales.

To this end, the projects are grouped into four categories:

- High priority – clear pass (pass on all three criteria);

- Medium priority – high marginal (marginal on one or two criteria);
- Low priority – low marginal (marginal on all three criteria); and
- Fail – failed on at least one of the criteria.

The following table summarises PPA Energy's assessment of the prioritisation.

Ref. #	**Measure**	**Priority**
04	Distribution losses	High
11	M&V	High
12	Awareness campaign (library)	High
13	Tariff setting principles	High
01	Generation dispatch	Medium
02	Energy trading in SAPP	Medium
03a	Hydro rehabilitation	Medium
03b	Coal rehabilitation	Medium
05	EEO	Medium
16	Regional negawatts	Medium
06	Smart Meter	Low
08	SWH capacity building	Low
10	Energy audits	Low
07	EE lighting roll-out	Fail
09	Operating reserves	Fail
14	National EE Action Plan	Fail
15	EE lighting regulation	Fail (not required to assess)

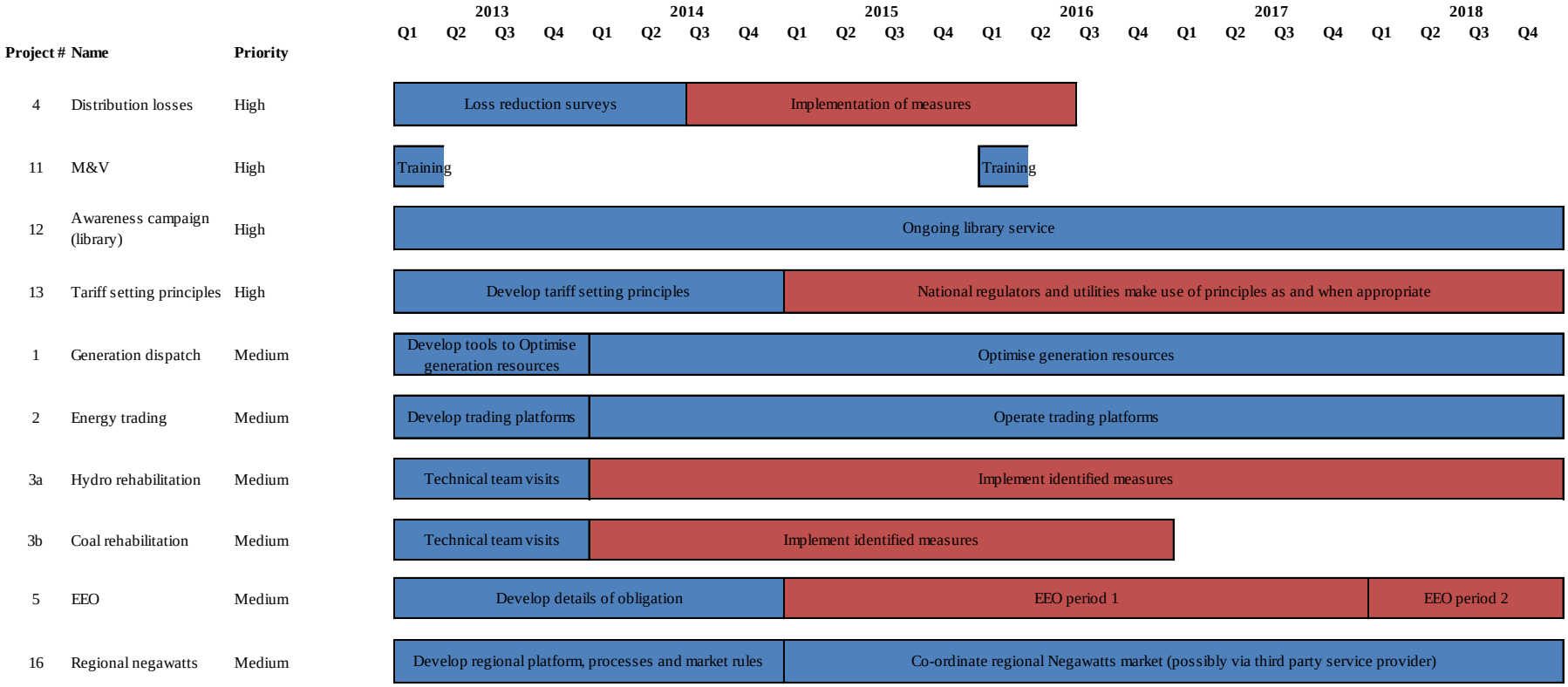
Ref. #	Measure	Priority
17	ToU tariff	Fail (not considered as stand-alone project)
18	Demand response for peak lopping	Fail (not considered as stand-alone project)

Table 13. Project prioritisation

In view of the subjective nature associated with the assessments under each criterion, views were sought from the SAPP-CC and SAPP members on the original evaluation of options during the first workshop, and on revised project evaluations during the second workshop. The above evaluations and prioritisations have been revised to take account of feedback.

An indicative project pipeline is shown below, with possible timescales for each project indicated. This is assuming that high and medium priority projects start in 2013. The pipeline does not show low priority projects; the need for these could be re-assessed at a later date. The blue bars are projects co-ordinated by the SAPP-CC; the red bars are projects implemented by other stakeholders, e.g. SAPP utilities.

Figure 9. Indicative project pipeline



6.8 Summary of Key Characteristics and Constraints

6.8.1 Key findings

In this Section 6 of the report, a set of initial energy efficiency and load-shifting projects has been proposed, based on input from the Needs Assessment Survey and review of currently implemented projects. Following an initial filter, the revised list of projects has been evaluated against a set of criteria, which in broad terms are suitability, acceptability and feasibility, to identify which projects would be suited to regional co-ordination by SAPP. The assessment of each project against the criteria has allowed for the projects to be prioritised. The evaluations and prioritisations have been revised to take account of SAPP member feedback; the full evaluations are presented in Appendix 5. The identification and recommendation of high and medium priority projects for regional implementation by SAPP are the key findings of this study.

The recommended high priority projects are:

- Distribution loss reduction project;
- Capacity building in Measurement and Verification (M&V) of EE and load-shifting projects;
- Awareness campaign library; and
- Tariff setting principles.

These projects have been recommended as high priority projects as they are considered to pass each of the three criteria.

A project in technical and non-technical distribution loss reduction had strong support from SAPP members in the Needs Assessment Survey; this is seen as a priority area by many SAPP members, with potential for high impact. When considering the impact, a 4% reduction in distribution losses in all SAPP utilities (excluding South Africa and Botswana, where distribution losses are reasonable) will save around 1,400 GWh per year. Benefits identified include: utilities having improved revenue collection; de-facto subsidies from paying customers to non-paying customers will reduce; reduced losses should help accelerate the connection of unserved areas by making more capacity available; and, a more sustainable power sector, as the utility has improved cost recovery and can use this revenue to contribute to future investment. The specific project identified for SAPP is to co-ordinate distribution loss reduction surveys in SAPP countries with the highest levels of distribution losses. The surveys will identify the level of losses, primary causes and recommend measures to reduce these losses. The estimated costs for distribution loss surveys are US$300,000 per country.

A project in capacity building in Measurement and Verification (M&V) for implementing EE and load-shifting projects also received strong support from SAPP members in the Needs Assessment Survey, which was emphasised during the first workshop. It is difficult to assess the impact of capacity building projects. However, this capacity building is seen as key to implementing EE projects; a lack of understanding of the impact of currently implemented EE measures was identified as a concern from the four-country visit. Benefits of this project include: improved M&V in EE projects implemented, which would allow the utility to assess projects and make well-informed decisions on future investments, and thus achieve more assured returns on investments; customers who are involved in EE projects would have improved feedback on their energy savings; and, governments would be more informed on the performance and savings of EE projects. The specific project identified for SAPP is to train staff from SAPP member utilities in Measurement and Verification, in order that the effectiveness of EE projects can be assessed, to aid planning for future projects. The estimated costs are US$115,000 for 3 members per utility, for all utilities excluding Eskom (which already has M&V training). It is recommended that staff are re-trained, or new staff are trained, every three years.

The definition of a project associated with an awareness campaign was refined at the first workshop. The consultants had initially evaluated a project whereby SAPP co-ordinated a regional awareness campaign. SAPP members indicated that a more valuable role for SAPP would be in providing and maintaining a library for campaign material, for SAPP members to make use of in running their own campaigns. This project has been re-evaluated, and its level of priority has increased to 'high'. As with the M&V training, it is difficult to assess the impact of this project, which is something that SAPP members have experienced themselves. However, it is noted that providing information to customers breaks down barriers to them implementing EE projects, and changing customer behaviour can result in significant energy savings. The benefits of this project include: the utilities having access to campaign material; and, customers having increased access to information, which will help them to make informed decisions on energy behaviour and investing in EE appliances or measures. The estimated annual costs for this project are US$16,000, which includes the tools / library platform and an allowance for staff time.

The project definition regarding reviewing tariff structures was also refined at the first workshop. The consultants had initially evaluated a project whereby SAPP co-ordinated a set of Cost of Service Studies, for those utilities who have not undertaken this activity. This project failed against the acceptability criteria, as it can be politically unacceptable with governments and customers to increase electricity prices. SAPP members felt that this assessment was appropriate for the project defined. However, views were expressed that cost reflective pricing is such as important issue, and that a role for SAPP in assisting utilities in this matter should be identified. It was agreed that the project description would be revised to SAPP, working together with RERA,

should develop a set of tariff setting principles. It is difficult to quantitatively assess the potential impact of tariff setting principles. However, the impact of reaching cost reflective tariff levels on EE projects is that the payback period will be shorter if prices are higher; cost reflective pricing is key in incentivising energy efficiency measures. The utility, if they follow the principles provided, will benefit from gaining a better understanding of the tariffs required to sustain their business, which will help them in making tariff applications to the regulator. It is estimated that the cost of developing a set of tariff setting principles, as a piece of consultancy work, would cost in the region of US$100,000 – US$150,000.

In addition to the above high priority projects that have been identified, a set of medium priority projects have been identified, which passed at least one criteria, and were marginal on the others:

- **Optimise generation dispatch**: Optimise hydro and thermal power plant dispatch in the SAPP interconnected system, to ensure that power stations are run in an optimal manner.

- **Optimise energy trading in SAPP**: Operate trading platforms to encourage vibrant market interaction between the member utilities and other trading members.

- **Rehabilitate hydro generation**: Co-ordinate a study to identify efficiency improvements that could be made to interconnected SAPP hydro generation.

- **Rehabilitate coal-fired generation**: Co-ordinate a study to identify least-cost short-term generation efficiency improvements that could be made to interconnected SAPP coal-fired generation (“quick wins”).

- **Energy Efficiency Obligation (EEO)**: Develop an EEO for each SAPP member; an obligation placed on electricity suppliers / retailers or Distribution Network Operators to meet an energy saving target (e.g. in the form of a number of GWh per year) by eligible measures.

- **Regional trading of negawatts**: Co-ordinate a regional aggregated demand response platform, which runs alongside other regional SAPP markets. The aggregating service could be managed by a third party.

For the projects that are considered to be high and medium priority, the key characteristics that have been identified in the project evaluation stage are summarised in the table below (Table 14).

6.8.2 Constraints and barriers

In implementing distribution loss reduction projects, there is a risk that after an initial improvement, losses begin to increase as utility staff and customers

revert to previous practices and behaviours, such as meter tampering, illegal connections and billing fraud. SAPP and utilities could work with RERA and regulators on performance monitoring of distribution losses, to try to maintain losses at an acceptable level. This could include setting targets for distribution loss reduction, and developing and promoting minimum standards of equipment efficiency. In addition to this, the SAPP-CC could co-ordinate the sharing of best practice in the region, so that SAPP utilities could share their experiences of successes and challenges of their loss reduction programmes. A major barrier to non-technical loss-reduction is a culture of electricity theft, which can take significant time and effort to reverse. In order to address this barrier, SAPP could work with governments to raise awareness of the detrimental impact to utilities of electricity theft. It is also important to gain support of government in administering penalties on non-paying customers, in order to prevent re-offenders.

A potential risk with capacity building is that trained staff leave the organisation or that knowledge deteriorates. In considering the project of capacity building in Measurement and Verification (M&V) it is suggested that SAPP retrains utility staff, or trains new staff where trained personnel have left the utility or are no longer working in relevant functions, every three years.

The above constraints and overcoming actions for SAPP were discussed and supported at the first workshop. The constraints and actions on the remaining two high priority projects were discussed with SAPP members at the second workshop.

In providing a library for awareness campaign material, a risk is that the material will not be updated, and the service will not be used. In order to address this, an allowance of staff time has been made when estimating the costs of this project. This staff time can be used to maintain the library, including publicising the availability of the library to relevant staff at SAPP utilities, reviewing the material in the library to check that it is up to date, and reminding utility personnel to upload their latest material.

The consultants originally considered that a constraint to the project for SAPP and RERA to develop a set of tariff setting principles was that it could be perceived by independent national regulators as unwanted interference. This was discussed at the second workshop. SAPP members did not believe that this would be seen as interference, and it was noted that reaching cost reflective tariffs is on the agenda of energy Ministers.

The constraints and barriers associated with each of the high and medium priority projects have been considered; this is summarised in the table below (Table 15). The table summarises the main constraints, as discussed in the full project evaluations (appendix 5), and considers how SAPP can contribute to overcoming these constraints. The original assessment of constraints was presented to SAPP members at the first workshop, and the revised constraints

presented at the second workshop. The table has been revised to take account of feedback.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
04	Distribution losses	Co-ordinate distribution loss reduction surveys in SAPP countries with the highest levels of distribution losses. The surveys will identify the level of losses, primary causes and recommend measures to reduce losses.	The benefits of the loss reduction surveys would be the identification of the most economic and high impact measures. Should loss reduction measures be implemented, a 4% reduction in distribution losses in all SAPP utilities (excluding South Africa and Botswana, where distribution losses are reasonable) will save around 1,400 GWh per year.	Estimated costs for a distribution loss surveys are US$300,000 per country. The costs of the measures implemented vary; only measures that are economic should be recommended for implementation.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
11	M&V	Training staff from SAPP member utilities in Measurement and Verification, in order that the effectiveness of EE projects can be assessed, to aid planning for future projects.	Capacity building in M&V is key in supporting utilities to implement energy efficiency projects. This view had strong support from SAPP members at the workshops. If just 1% of an assumed 10% (i.e. 0.1%) of savings in SAPP countries by 2025 is attributable to M&V training, then net present value (NPV) is positive with high internal rate of return (IRR).	Estimated costs are US$115,000 for 3 members per utility, for all utilities excluding Eskom (which already has Measurement and Verification training), in 2012 prices. It has been assumed that staff are re-trained, or new staff are trained, every three years.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
12	Awareness campaign – library	SAPP-CC to act as a central body to gather campaign material from, and share campaign material with, SAPP members, for them to make use of in their own marketing campaigns.	A library for campaign material allows SAPP members to access material to make use of in their own campaigns. It also provides an opportunity for utilities to share examples of best practice projects and success stories. If just 0.1% of an assumed 10% (i.e. 0.01%) of savings in SAPP countries by 2025 is attributable to the awareness campaign library, NPV is positive with high IRR.	Annual costs to SAPP-CC associated with running the library are estimated at US$16,000 in 2012 prices. This includes the tools / library platform and an allowance for staff time.
13	Tariff setting principles	SAPP, working together with RERA, should develop tariff setting principles, to help to raise awareness of tariff approval at the country level, as well as giving guidelines on setting tariffs to be cost reflective (cost recovery is a key principle of tariff setting).	The benefits of a set of tariff setting principles include supporting utilities in making tariff applications and, if appropriate, working towards cost reflective tariffs.	The costs of such a project are estimated at US$100,000 - 150,000.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
01	Generation dispatch	Optimise hydro and thermal power plant dispatch in the SAPP interconnected system, to ensure that power stations are run in an optimal manner.	There are potential economic and energy saving benefits specifically from the optimisation of hydro and thermal resources. These need to be determined, and could be a topic for SAPP-driven research.	
02	Energy trading	Operate trading platforms to encourage vibrant market interaction between the member utilities and other trading members.	Trading surplus generation in real-time will enable some energy efficiency, specifically where the energy would otherwise be wasted such as hydro spillage. Dynamic trading of energy could result in units operating in their optimal efficiency range. The potential savings need to be determined, and this could be a topic for SAPP-driven research.	Costs of a trading platform are dependent on the complexity of the trading rules and are estimated to be in the order of US$10 million.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
03a	Hydro rehabilitation	Co-ordinate a study to identify efficiency improvements that could be made to interconnected SAPP hydro generation.	The benefit of the team visit is the identification of energy efficiency measures suitable for SAPP plant. These measures would result in improved efficiency in generation, i.e. reducing technical losses / resulting in an improved electricity generation output for a given level of input (water intake). If 25% of hydro generation in SAPP countries was rehabilitated with a resulting 15% improvement in generating capacity, this would provide around 356MW of base-load and/or peak capacity. Assuming a 50% plant load factor, this represents an additional 1,500 GWh of energy production.	The cost of a team of 5 to visit 10 power stations and make recommendations is estimated at US$420,000. The cost for rehabilitating 25% of the installed hydro capacity in SAPP is US$231 million associated with achieving additional capacity from energy efficiency improvements (US$463 million in total including the costs for life extension), plus the additional costs associated with Operation and Maintenance.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
03b	Coal rehabilitation	Co-ordinate a study to identify least-cost short-term generation efficiency improvements that could be made to interconnected SAPP coal-fired generation ("quick wins").	The benefit of the team visit is the identification of energy efficiency measures suitable for SAPP plant (e.g. changes that can be made while the plant is online). These measures would result in improved efficiency in generation, i.e. an improved electricity generation output for a given level of fuel (coal). Potential plant improvement is typically in the range 3-6% conversion efficiency savings, with practical or economic improvements in the range 2-4% where the plant has not been upgraded previously	The cost of a team of 5 to visit 5 power stations and make recommendations is estimated at US$210,000. The cost associated with rehabilitating 25% of the installed coal capacity in SAPP (excluding South Africa) is estimated at US$46 million.

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
05	EEO	Developing an EEO for each SAPP member; an obligation placed on electricity suppliers / retailers or Distribution Network Operators to meet an energy saving target (e.g. in the form of a number of GWh per year) by eligible measures.	The benefits of developing an Energy Efficiency Obligation include setting a quantitative target for energy savings, promoting and stimulating investment in energy efficiency at a relatively modest cost to customers, and the party responsible identifying the most cost-effective and fast-acting measures. As an example, if 2%[36] savings on annual consumption were achieved in SAPP countries, this would equate to 5.2 TWh per year on current consumption levels. If targeted at the residential and commercial sectors, a 2% saving would equate to 2,700 GWh after 3 years (557 GWh excluding South Africa).	The costs of developing an EEO are difficult to assess. The budgets for achieving the targets are estimated as 1-2% of bills for residential and commercial customers. This is US$292 million over a 3-year period (US$77.9 million excluding South Africa).

[36] This falls within the range of targets that has been used in other countries

Ref. #	Project	Description of project for SAPP (technical characteristics)	Expected impacts	Indicative costs
16	Regional negawatts	Co-ordinating a regional aggregated demand response platform, which runs alongside other regional SAPP markets. The aggregating service could be managed by a third party.	Experience in South Africa with this project has shown that around 800 MW of demand response currently submits offers to reduce demand; this represents around 2% of peak demand in South Africa. If similar percentage levels were achieved regionally this would correspond to 135 MW (excluding South Africa) at peak time.	The costs associated with developing and running such a platform would need to be determined for the SAPP region, as the platform would be tailored to SAPP's requirements. However, the costs associated with unserved energy due to load shedding are considerable, so there are significant potential benefits in reducing unserved energy.

Table 14. Summary of key characteristics

Ref. #	Project	Constraints, barriers and risks	Possible actions for the SAPP-CC and SAPP utilities
04	Distribution losses	After initial improvement, losses increase due to reverting to previous practices or behaviour	Work with RERA / Regulators on monitoring performance of distribution losses, setting targets for distribution losses and developing or promoting minimum standards of equipment quality and efficiency. SAPP utilities could share experiences of the successes and challenges of distribution loss reduction programmes. This could be co-ordinated by the SAPP-CC.
		A culture of electricity theft	Work with governments to raise awareness of the damage to utilities of high levels of theft, and gain their support in administering any penalties or sanctions on non-paying customers, as a deterrent to re-offend.
11	M&V	Trained staff leave the organisation / knowledge deteriorates	SAPP could periodically re-train staff that have benefited from training, or train new staff where trained personnel have left SAPP utilities.
12	Awareness campaign library	The material is not updated / the service is not regularly used.	There is an allowance for staff time to maintain the library. This could include publicising the availability of the service, reviewing the material to check it is up to date, and reminding utility personnel to upload the latest material.

Ref. #	Project	Constraints, barriers and risks	Possible actions for the SAPP-CC and SAPP utilities
13	Tariff setting principles	May be seen as unwanted interference by independent national regulators	The voluntary nature of principles means that utilities and regulators can receive guidance on an issue that is important in the SAPP region, whilst allowing individual countries to work towards cost-reflective pricing at their own pace. This issue was discussed at the second workshop, and it is not considered by SAPP members to be a constraint for this project.
01	Generation dispatch	Utilities with hydro resources do not have tools to calculate available hydro capacity ahead of time. Thus the utility is forced to spill even with hydro units operating at full output	SAPP could investigate hydro flow modelling tools for accurate prediction of surplus hydro power for the region. At the first workshop, the SAPP-CC indicated that they do not consider this to be a potential constraint, and that utilities should have hydro flow modelling tools for accurate prediction of surplus hydro power for the region. HCB noted that even with such tools it is difficult to predict flow levels, and agreements with stakeholders can mean that at times, water has to be spilled to maintain agreed water levels.
		Transmission constraints limit regional trading	SAPP has a Planning Sub-Committee (PSC), whose role includes considering regional upgrades required to transmission lines.

Ref. #	Project	Constraints, barriers and risks	Possible actions for the SAPP-CC and SAPP utilities
02	Energy trading	SAPP unable to determine transmission available capacity in real-time and for the rest of the trading day	SAPP SCADA system to be developed to calculate available transmission capacity in real-time and for the rest of the trading day. At the first workshop, the SAPP-CC indicated that a SAPP SCADA system was commissioned in 2011. They do not consider this to be a constraint.
		Transmission constraints limit regional trading (as above)	SAPP has a Planning Sub-Committee (PSC), whose role includes considering regional upgrades required to transmission lines (as above).
03	Hydro and coal rehabilitation	Time taken to undertake the rehabilitation	For coal-fired generation, SAPP should specify that the study focuses on "quick win" measures to improve efficiency. If this is of interest to SAPP, the studies should be undertaken as soon as possible.
		Taking plant out of service when there are supply-side constraints	This is alleviated by taking out one unit at a time, although doing this extends the timescale of the project.
		Efficiency improvements are not maintained / made to other plant	Work with RERA / regulators on monitoring performance of generator efficiency, setting targets for generation efficiency and developing or promoting minimum standards of equipment efficiency and quality.

Ref. #	Project	Constraints, barriers and risks	Possible actions for the SAPP-CC and SAPP utilities
05	EEO	Enforcing the target	If the target is a legal obligation, this will require legislation to be passed, which is time consuming and outside of SAPP's scope of activity. Alternatively the targets could be agreed between regulators / SAPP utilities; penalties or sanctions for failing to meet targets would need to be considered.
		Interaction with existing policy measures	In the design of the obligation, consideration would need to be given to existing policy mechanisms. The obligation would need to be designed such that customers cannot "double count" a project and benefit financially from more than one scheme.
		M&V hampered by low metering coverage	In some SAPP countries metering coverage is low, and this could make M&V difficult. Metering coverage should be considered in distribution loss studies. A proportional approach to M&V needs to be considered for the obligation, and could be based estimating savings based on a sample of measured examples.
		Cost to customers	SAPP needs to consider whether passing the costs of an obligation onto customers is acceptable or not.

Ref. #	Project	Constraints, barriers and risks	Possible actions for the SAPP-CC and SAPP utilities
16	Regional negawatts	Changes need to be made to the legal framework (regulations and licences) to allow demand customers to participate in SAPP markets – this could cause delays.	This issue was discussed at the second workshop. The extent to which this is a constraint will depend on the desire to make the changes to facilitate such a platform. As below, the SAPP-CC should investigate the appetite for such a market, in order to support any changes required.
		As power plants are built, this may become a less attractive option.	The offering of negawatts is particularly attractive during supply constraints. However, depending on the prices requested to reduce demand, the service may be competitive with the cost of generation, and in particular peaking plant, which tends to be the more expensive generation in a portfolio.
		Use of the service / market is low.	The SAPP-CC should investigate the appetite for such a market with SAPP members.

Table 15. Summary of constraints