National Policy Roadmap

National Policy Report on Residen tial Refrigerators in Lesotho

25 September 2022

UN environment programme

U4E United for Efficiency

GREEN CLIMATE FUND

CTCN UN Climate Technology Centre & Network UNFCCC Technology Mechanism

PEGASYS CHANGING LIVES CHANGING WORLDS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AFDB	African Development Bank
CTCN	UN Climate Technology Centre and Network
DoE	Department of Energy
GCF	Green Climate Fund
HEPS	Higher Energy Performance Standard
IMF	International Monetary Fund
kV	Kilo Volts
kVA	Kilo Volts Ampere
LEC	Lesotho Electricity Company
LEWA	Lesotho Electricity and Water Authority
LNDC	Lesotho National Development Corpocration
LSI	Lesotho Standards Institute
LSL	Lesotho Loti
MEPS	Minimum Energy Performance Standards
MV&E	Monitoring, Verification and Enforcement
RSL	Revenue Services Lesotho
SADC	Southern African Development Community
SANS	South African National Standard
TCO	Total Cost of Ownership
U4E	United for Efficiency
UNEP	United Nations Environment Programme

1 INTRODUCTION

The 'Leapfrogging to Energy Efficient Appliances and Equipment in Lesotho (Refrigerators and Distribution Transformers)' project is funded by the Green Climate Fund (GCF) and being implemented under the guidance of the government of the Kingdom of Lesotho (Lesotho). The project is also being implemented simultaneously within 7 other countries of the Southern African Development Community (SADC) region, namely Botswana, Zimbabwe, Namibia, Malawi, Eswatini, Zambia and Tanzania. Lesotho is one of the few countries in the world that is completely encircled by another country and is completely contained within the borders of South Africa. Lesotho does not have access to the coast/sea and is therefore heavily reliant on trade with South Africa. The electrification rate in Lesotho is currently below 45% but it is on the increase as a result of the government of Lesotho's electrification campaign, executed via the Lesotho Electricity Company (LEC). Electrification is also expected to drive economic growth in the country. At present, Lesotho imports over 60% of its electricity from South Africa which contributes to higher costs and emissions (South Africa's generation capacity is heavily reliant on fossil duels). For this reason, the average price of electricity (generation + import) in Lesotho is quite high and any losses are hence expensive. Once connected to the grid, distribution transformers are in constant operation, supplying power to all electrical devices on their designated network. The no-load losses of a transformer exist irrespective of electricity usage, whereas the load losses vary as the electricity usage changes. As they always consume energy, improvements in their efficiencies have a continuous impact on the electricity infrastructure in Lesotho.

The aim of the project is to focus on distribution transformers and household refrigeration appliances and attempt to establish a framework in order to improve the energy efficiency of these appliances. This is to be done through the establishment of national standards for both refrigerators and distribution transformers and development of Minimum Energy Performance Standards (MEPS) as well as an energy labelling scheme for both these appliances. The project also engages with the key stakeholders within the country to create a system through which the necessary legislation can be developed related to the implementation of the MEPS and to create a national implementation plan that will both enable the implementation of the MEPS but also create a framework within Lesotho for future development of related standards and legislation. Furthermore, the project investigates the possible financing mechanisms available to assist with implementation of the project and the respective training programmes to enable transition into a self-sustained and managed implementation of the project in the future. Pegasys was contracted by the UNEP through the UN Climate Technology Centre and Network (CTCN) to implement this initiative in Lesotho. The CTCN is overseeing the project together with United for Efficiency (U4E) as a technical partner. This report focuses on distribution transformers. As part of the project a number of tasks have been completed and deliverables finalised. These include:

1. Development of the Lesotho National Standard on energy efficiency of distribution transformers [8] (including MEPS and HEPS)

2. Development of the Lesotho Energy Label (draft)

3. Development of the consumer awareness campaign
4. Development of the recommendations related to the financial supporting mechanisms
5. Development of the MV&E plan

This report outlines the National Policy Roadmap for the project in Lesotho related to distribution transformers. The remaining sections thus outline the background to the project and the impact it can have on Lesotho. There are explanations of the national standard and the energy label and how it related to the regional standard. Furthermore, the implementational aspects are covered in more detail. These include the MV&E implementation and monitoring parts of the project, where recommendations of implementation are detailed. The supporting aspects of the implementation in the form of the consumer awareness and financial mechanisms are explained in more detail. It is important to note that there are separate, more detailed reports on individual aspects of the project, including the energy label, consumer awareness campaign, financial mechanisms and the MV&E plan. However, this report outlines the most important part of each of these aspects and groups them in such a way that a policy roadmap for implementation of the entire project is created. Importantly, the outline of the overall project budget is also presented, with actions and responsibilities.

2 Background

As indicated in the annual reports compiled by LEWA [2], Lesotho is reliant on energy imports from South Africa as there is insufficient generation capacity within the country at present. The legal, regulatory and standardisation frameworks are generally inexperienced and untried regarding energy efficiency. Additionally, the general population is largely unaware of the benefits of energy efficiency and much work will need to be undertaken on the public awareness campaigns related to this issue.

However, there are several opportunities for a successful implementation of MEPS in the refrigeration and distribution transformer environment. These are:

- Successful implementation of MEPS in the refrigeration and distribution transformer sectors could open a pathway to implement similar projects in other sectors and with other appliances (e.g., washing machines and dishwashers, stoves and ovens, air conditioners, etc.)

- Successful training of the customs officials of the Revenue Services Lesotho (RSL – previously known as the Lesotho Revenue Authority - LRA) in relation to energy efficiency compliance will make them more capable of enforcing other governmental initiatives related to energy efficiency and quality on a variety of products (e.g.,air conditioners, power cables, etc.)

- Development of energy efficient appliances could lead to a green building revolution in Lesotho and align with the national energy policies

- Increasing public awareness related to energy efficiency would be beneficial to the general behaviour of the population towards energy use and could provide general energy saving benefits and an energy conscious behaviour beyond the confines of this project.

In order to successfully implement the newly developed Lesotho National Standard on energy efficiency of distribution transformers [8], the benefits of energy efficiency must be understood, appreciated and supported by all stakeholders. It is therefore imperative that engagement, training and consumer awareness be championed throughout the process. Distribution transformers are used solely in electrical networks and unlike refrigerators, are not encountered by the general public. Instead, large industry, electrical utilities, tertiary engineering institutions and the various governmental departments concerned with energy are the targeted audience. It is also important to note that transformers are imported into Lesotho as is no transformer manufacturing capability within the country.

The import numbers are shown in Figure 1 below.

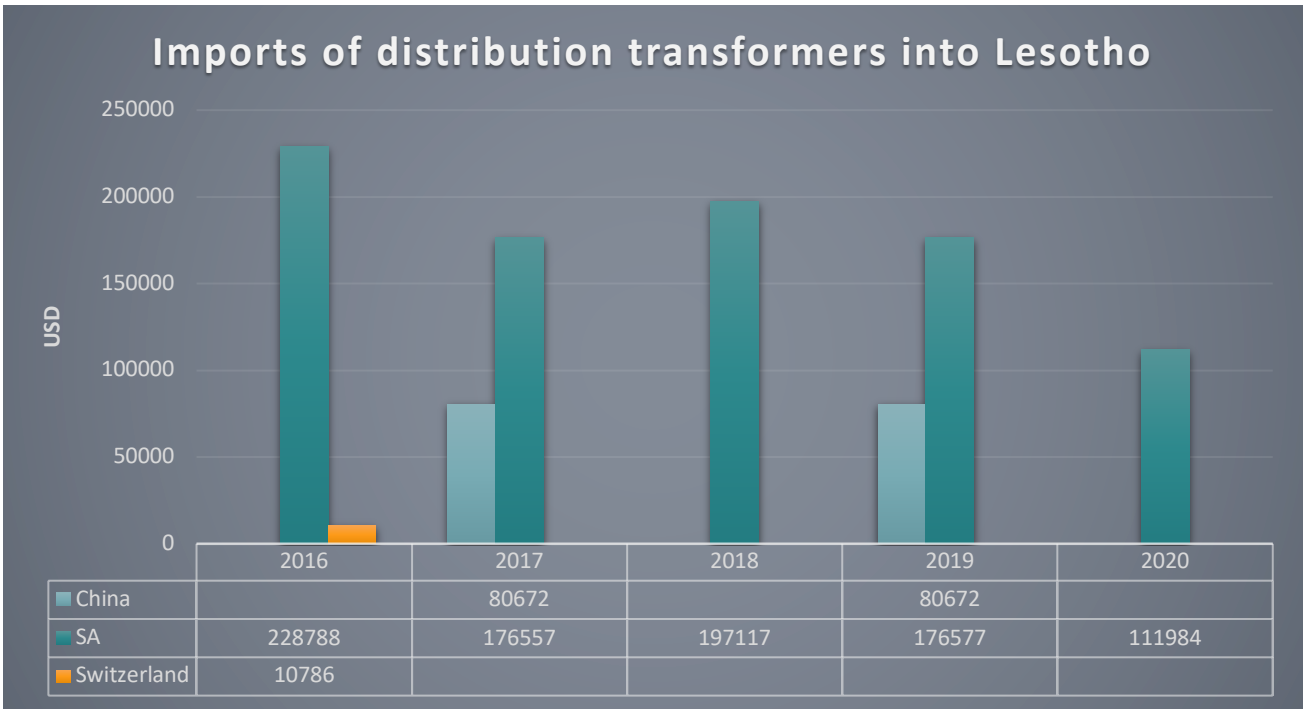

Figure 1: Transformer Imports since 2016 [1]

Information on the import of distribution transformers into Lesotho was obtained via the United Nations Global Trade Repository, Comtrade [1]. The trade data, seen in **Error! Reference source not found.** above, shows that in the period from 2016 – 2020, South Africa was the largest importer of transformers into Lesotho. China was the minority partner in 2017 and 2019, while a small number of transformers were imported from Switzerland in 2016. Lesotho has no local transformer manufacturing capabilities and hence does not export any transformers.

In order to analyse the energy efficient of the distribution transformers installed on the Lesotho electricity network an accurate database of the transformers was required. This proved to be a challenge as the Lesotho Electricity Company (LEC) had last updated their database in 2015. Since then, details of the transformers added to their network via the electrification programme were not captured. To overcome this hurdle the data published by the regulator regarding the growth in electricity usage attributed to increased access to electrification was used to project the number of transformers added to the grid since 2015 [2].

The increase in total usage due to increased electrification is shown in Figure 2 below.

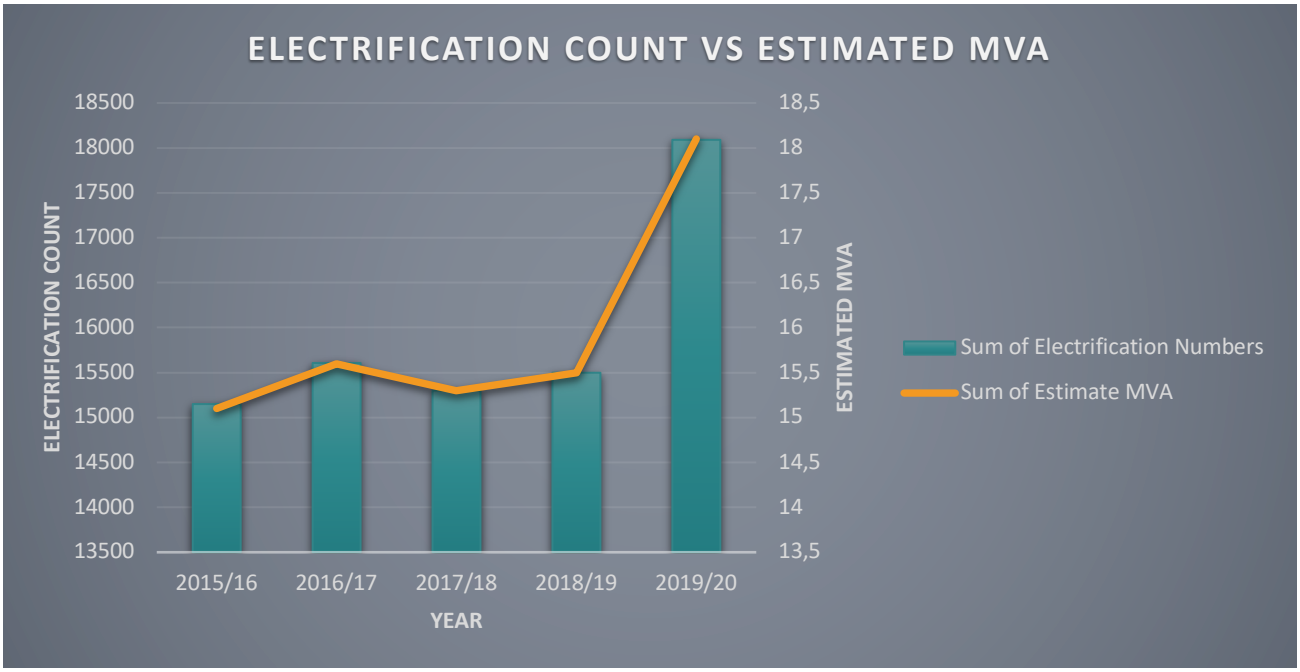

Figure 2: The increase in Total Usage Due to Increased Electrification

A further complication arose regarding the proportion of transformers added to the grid from increased electrification as the number of new connections added to existing installations were unknown. If new transformers are installed for every new connection, then the LEC asset base will increase, whereas utilising existing transformers will maintain LEC's asset base. Since 50 kVA and 100 kVA are the most used transformers within LEC's infrastructure it is assumed that a large portion of electrified customers are supplied by these units.

Tables 1 and 2 illustrate potential increases (in 20% increments) to LEC's asset base for both transformer ratings. For example, in 2015/16, LEC electrified 15 149 customers. Assuming 1 kVA per customer connection yields an annual estimate of 15.1 MVA. If 80% of these customers are connected using existing transformers in the field and 20% are new 50 kVA transformers, LEC will increase their asset base by 61 transformers. If only 20% of 100 kVA transformers are utilised for the same scenario, then the LEC will increase its asset base by 31 transformers.

Table 1: Electrification numbers for 50 kVA Transformers

Year	Electrification Numbers	Estimated MVA	20% New Trfrs	40% New Trfrs	60% New Trfrs	80% New Trfrs	100% New Trfrs
2015/16	15149	15.1	61	121	182	242	303
2016/17	15606	15.6	62	125	187	250	312
2017/18	15299	15.3	61	122	184	245	306
2018/19	15498	15.5	62	124	186	248	310
2019/20	18090	18.1	72	145	217	289	362

Table 2: Electrification numbers for 100 kVA Transformers

Year	Electrification Numbers	Estimated MVA	20% New Trfrs	40% New Trfrs	60% New Trfrs	80% New Trfrs	100% New Trfrs
2015/16	15149	15.1	30	61	91	121	151
2016/17	15606	15.6	31	62	94	125	156
2017/18	15299	15.3	31	61	92	122	153
2018/19	15498	15.5	31	62	93	124	155
2019/20	18090	18.1	36	72	109	145	181

While not ideal, this exercised allowed for a more accurate representation of the number of transformers on the LEC grid.

Throughout its tenure, the LEC purchased transformers according to the requirements stipulated by the South African Standard SANS 780 [3]. The transformer losses stipulated in SANS 780 remained unchanged until 2019 [4]. We were therefore able to ascertain the efficiencies of the transformers in the LEC grid and determine the impact of their losses on their impact on the electricity network. This information also allowed for the calculation of savings that the LEC would have seen should they have employed a TCO approach to procurement [6] and transformer standards that promoted higher efficiencies.

The results of the comparison exercise are shown in detail in the Market Assessment Report [7]. The Market Assessment Report shows that there are significant advantages to be gained by promoting the procurement of higher efficiency transformers and by developing and implementing MEPS in Lesotho. It is important that the development of MEPS is underpinned by a thorough implementation plan, which will allow the national stakeholders to sustain the implementation and develop the required legislation. It is also key that a financial backing for the implementation is planned and that there is a thorough skills transfer process in place as part of the implementation.

To reap the benefits of the transformer efficiency project, it is important for Lesotho to develop and implement:

- a national standard,
- an energy label,
- a regulatory framework,
- an implementation plan,
- supporting structures such as verification programs and consumer awareness campaigns,
- a plan for obtaining financial backing for the implementation of the project.

The sections 3 to 7 of this report cover each of these aspects in more detail.

3 National Standard for Efficiency of Distribution Transformers in Lesotho

3.1 CONTEXT

In parallel with this project, MEPS are being implemented in 7 other SADC countries, namely, Botswana, Eswatini, Malawi, Namibia, Tanzania, Zambia and Zimbabwe.

The scope of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] relates to liquid-immersed distribution transformers that are manufactured in, or imported into Lesotho, and are either sold, installed or put into service as standalone equipment or as a component of a system, and which meet the following criteria:

Distribution transformers within scope have:

- 2 windings per phase.
- a rated capacity equal to or between 5 kVA and 3150 kVA.
- a primary voltage greater than 1,1 kV, but not exceeding 36 kV; and
- are designed for use in electricity networks or industrial applications.

Distribution transformers regardless of when they were first placed on the market or put into service, shall be reassessed for conformity, and comply with this standard if they are subject to replacement operations both of the core (or part thereof) and one (or more) of the complete windings.

This standard does not apply to:

- instrument transformers, specifically designed to transmit an information signal to measuring instruments, meters, relays and other similar apparatus.
- dry type transformers.
- transformers with low-voltage windings specifically designed for use with rectifiers to provide a DC supply.
- transformers specifically designed to be directly connected to a furnace.
- transformers specifically designed for offshore applications and floating offshore applications.
- transformers specially designed for emergency installations.
- transformers and auto-transformers specifically designed for railway feeding systems.

- earthing or grounding transformers, this is, three-phase transformers intended to provide a neutral point for system grounding purposes.
- traction transformers mounted on rolling stock, this is, transformers connected to an AC or DC contact line, directly or through a converter, used in fixed installations of railway applications.
- starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips.
- testing transformers, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment.
- welding transformers, specifically designed for use in arc welding equipment or resistance welding equipment.
- transformers specifically designed for explosion-proof and underground mining applications.
- transformers specifically designed for deep water (submerged) applications; and
- Medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA.

3.2 NATIONAL STANDARD (MEPS)

Transformers in the scope of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] must comply with the maximum allowed load and no-load losses values set out in the following tables. If not otherwise specified, three phase or single-phase power transformers shall be evaluated against the rated power of the individual unit. Maximum allowable losses rated powers that fall in between the given values shall be obtained by linear interpolation.

Table 3: Maximum load loss and maximum no load loss for liquid-immersed single-phase transformers with Um <= 36kV and rated frequency equal to 50 Hz

Rated power (kVA)	Tier 1			Tier 2			Tier 3		
	Maximum load losses (in W)	Maximum no-load losses (in W)	EI_{A50} %	Maximum load losses (in W)	Maximum no-load losses (in W)	EI_{A50} %	Maximum load losses (in W)	Maximum no-load losses (in W)	EI_{A50} %
5	133	37	97.17%	123	28	97.68%	112	18	98.18%
10	243	44	97.90%	224	33	98.23%	205	21	98.56%
15	331	58	98.13%	305	43	98.42%	278	27	98.71%
16	346	60	98.16%	319	44	98.45%	292	28	98.73%
25	486	83	98.36%	448	61	98.61%	410	39	98.87%
32	599	93	98.48%	552	69	98.71%	505	44	98.94%
50	889	119	98.63%	819	88	98.83%	749	56	99.03%
64	1070	145	98.71%	986	106	98.90%	901	68	99.08%
100	1535	211	98.81%	1414	155	98.98%	1293	99	99.16%

Table 4: Maximum load loss and maximum no load loss for liquid-immersed three-phase transformers with Um <= 36kV and rated frequency equal to 50 Hz

Rated power (kVA)	Tier 1			Tier 2			Tier 3		
	Maximum load losses (in W)	Maximum no-load losses (in W)	EI_{A50} %	Maximum load losses (in W)	Maximum no-load losses (in W)	EI_{A50} %	Maximum load losses (in W)	Maximum no-load losses (in W)	EI_{A50} %
25	520	70	98.40%	460	56	98.63%	400	42	98.86%
50	880	110	98.68%	782.5	92	98.85%	685	74	99.02%
100	1500	190	98.87%	1340	156	99.02%	1180	122	99.17%
160	2200	270	98.98%	1930	225	99.12%	1660	180	99.26%
250	3100	380	99.08%	2715	320	99.20%	2330	260	99.33%
315	3600	450	99.14%	3200	387	99.25%	2800	324	99.35%
400	4400	540	99.18%	3825	463.5	99.29%	3250	387	99.40%
500	5200	630	99.23%	4550	544.5	99.33%	3900	459	99.43%
630	6200	750	99.27%	5400	645	99.37%	4600	540	99.46%
800	7500	900	99.31%	6750	742.5	99.39%	6000	585	99.48%
1000	8900	1070	99.34%	8200	855	99.42%	7500	640	99.50%
1250	10500	1260	99.38%	9650	1025	99.45%	8800	790	99.52%
1600	12800	1520	99.41%	11800	1247.5	99.48%	10800	975	99.54%
2000	15100	1790	99.44%	14050	1460	99.50%	13000	1130	99.56%
2500	18000	2120	99.47%	16750	1720	99.53%	15500	1320	99.58%
3150	21500	2520	99.50%	20250	2075	99.55%	19000	1630	99.59%

The standard also caters for distribution transformers having dual voltage and have kVA ratings different from the standard transformer ratings.

The energy performance requirements set out in the standard also stipulates the dates that the different MEPS shall take effect. These are stipulated as follows:

- Tier 1 - one (1) year after adoption of MEPS or 1 July 2023, whichever is sooner.
- Tier 2 - four (4) years after adoption of MEPS or 1 July 2026, whichever is sooner.
- Tier 3 - seven (7) years after adoption of MEPS or 1 July 2029, whichever is sooner.

3.3 RECOMMENDATIONS

The National Standard for Efficiency of Distribution Transformers in Lesotho [8] has been finalised and is currently in the process of public consultation. The standard was workshopped extensively with the nominated stakeholders of distribution transformers in Lesotho and was drafted during the Technical Committee Meetings, under the guidance of the Lesotho Standards Institute (LSI).

The final version of the standard was decided upon in June 2022. The standard was then sent for public comment. The aim was for this process to take 1 month. However, through the requirement to reach more of the public through various means this process was extended by the LSI to 2 months. The final comments are due to be received on the 11th of October 2022. Thus far there has been zero comments or objections to the standard. There is therefore a strong likelihood that the National Standard for Efficiency of Distribution Transformers in Lesotho [8] will be adopted as drafted in October 2022. If there are any comments the Technical Committee will be reconvened to assess these comments, make decisions on whether to adopt or reject them

and then finalise the standard. This will therefore provide Lesotho with its national standard on energy efficiency of distribution transformers.

The standard is in line with the recommendations of the Regional Standard for Efficiency of Distribution Transformers in SADC [9]. The standard also addresses the requirements for energy labelling and provides clear guidelines for manufacturers with respect to the information to be displayed on every label.

Recommendations

- It is recommended that purchasers state clearly that the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] for Transformer Efficiency takes precedence over any document stipulating transformer losses and provision of energy labels on transformers, such as SANS 780 of 2009 and 2019 [3][4].
- It is recommended that purchasers of distribution transformers employ a total cost of ownership strategy in the procurement process, whereby the losses are capitalised over the expected operational lifetime of the transformer. A tool was developed by the U4E to assist with the calculation of the capitalisation values.
- It is recommended that the capitalisation values be provided by the purchaser together with the National Standard for Efficiency of Distribution Transformers in Lesotho [8] in the technical documentation during any Procurement Tenders or individual RFQ's (requests for quotes).

3.4 ACTIONS

As mentioned above the National Standard for Efficiency of Distribution Transformers in Lesotho [8] been drafted. The standard is currently in the process of receiving public comments. The public consultation phase ends on the 11th of October 2022. Once the final comments are received (if there are any comments) a meeting of the TC will be convened. At this meeting the comments will be discussed and decisions made as to whether these comments should be included in the final revision or whether the comments are to be discarded. At the end of this meeting the final national standard for Lesotho can be adopted.

The LSI will remain as the custodian of the standard and will be responsible for the continuous improvement of the standard as the evolution of technology in the engineering sector allows for more stringent MEPS to be pursued. The LSI will undertake to review the National Standard for Efficiency of Distribution Transformers in Lesotho [8] at such time, in conjunction with stakeholders that hold an interest in distribution transformers in the country. Stakeholders that may hold an interest in the revision of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] are shown in Table 5 below.

Table 5: Stakeholders that may hold an interest in the revision of National Standard for Efficiency of Distribution Transformers in Eswatini [8]

Stakeholders	Responsibility
LSI	Responsible for maintenance and development of the standard.
LEC, Lesotho National Development Corporation (LNDC)	Utility - User of distribution transformers. Changes to the standard may have commercial and operational impacts on the user.
Private Users such as the brewery and the mining industry	User of distribution transformers. Changes to the standard may have commercial and operational impacts on the user.
Wholesalers/ Redistributors of Transformers	Resellers -Changes to the standard may have commercial implications.
Academic Institutes	Tertiary Institutions focused on Electrical Engineering – May be interested in the impact of MEPS on the energy sector.
Repair Facilities for Distribution Transformers	Changes to the standard may have commercial and operational impacts on the repairers of transformers.

3.5 EXPERIENCE OF IMPLEMENTING MEPS IN SOUTH AFRICA

By 2008, the state-owner utility of South Africa, Eskom, was struggling to keep up with the generation capacity needed to service the country. The growing demand for electricity spurred on by the country's electrification campaign placed great strain on Eskom's Generation Division. Improvements in the efficiency of distribution transformers procured by Eskom was emphasised as a factor that could alleviate the strain on the generation needs of the country.

Eskom found that the South African National Standard for Transformers, SANS 780, 2009 South African National Standard, Transformers [3], proved to be a major barrier to procuring more efficient distribution transformers as the MEPS stipulated in [3] had remained unchanged since the 1960s. To overcome this obstacle Eskom amended its procurement process to from procuring on the lowest capital cost of transformers to a total cost of ownership (TCO) approach that capitalized the no-load and load losses.

In addition to TCO, Eskom engaged with the South African Bureau of Standards to revise South African National Standard for Transformers, SANS 780, 2009 South African National Standard, Transformers [3]. In 2019, South African National Standard for Transformers, SANS 780, 2019 South African National Standard, Transformers [4] was released, and found to be in-line with the MEPS stipulated in Tier 1 of the international specification, IEC, 2017. Power Transformers – Part 20: Energy efficiency. Technical Specification, IEC TS 60076-20. Edition 1.0 2017-01 [5].

In this fashion, HEPS were pursued by the TCO and driven by the rising costs of energy. Capitalisation values for no-load and load losses are issued for every transformer tender and tenders are awarded on a TCO basis.

In addition to the TCO Eskom pursued two other initiatives to lower the impact of carbon emissions due to distribution transformers, namely:

- A project to assess the viability of low loss amorphous core transformers, and
- A transition away from the use of mineral oil in distribution transformers to an environmentally friendly natural ester oil alternative.

Amorphous core transformers have been included in the Eskom transformer specification, 240-45395762 – Eskom Specification for Pole and Ground Mounted Transformers [12], as a voluntary option for transformer manufacturers to pursue for an advantage in the TCO.

Since 2019, 30% of Eskom's new distribution transformers has been procured with natural ester oil. This ratio is expected to increase significantly in future distribution transformer contracts as local manufacturers have completed the infrastructure required to use natural ester oils during production.

4 Energy Label

4.1 CONTEXT

The technical data pertaining to transformer losses and efficiency is listed on the rating plate of all transformers and is a requirement stipulated by functional specifications such as SANS 780 and IEC 60076 [3][4][5]. Some of the SADC countries have therefore decided not to make a separate energy label a mandatory requirement. There was also concern raised over the durability of the label in the harsh southern African environment given that distribution transformers are exposed to the elements, unlike other equipment like refrigerators that are almost exclusively used indoors.

Lesotho, however, decided in favour of having a dedicated energy efficiency label for transformers as it will be of benefit to non-technical staff such as those at the ports of entry, who may find it difficult to decipher a transformer rating plate.

All distribution transformers manufactured for use in Lesotho should be clearly labelled to indicate the tier of losses that the transformer complies to, in accordance with the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8].

The labels will assist port authorities in preventing non-compliant transformers from entering Lesotho. The Ports Authority will correlate the losses stipulated on the transformer's rating plate and energy label to the tiers of losses stipulated in accordance with the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. Non-compliant transformers will not be allowed entry into Lesotho.

The label is in line with the MEPS and timelines set out the National Standard for Efficiency of Distribution Transformers in Lesotho [8] and is shown in Figure 3 below.

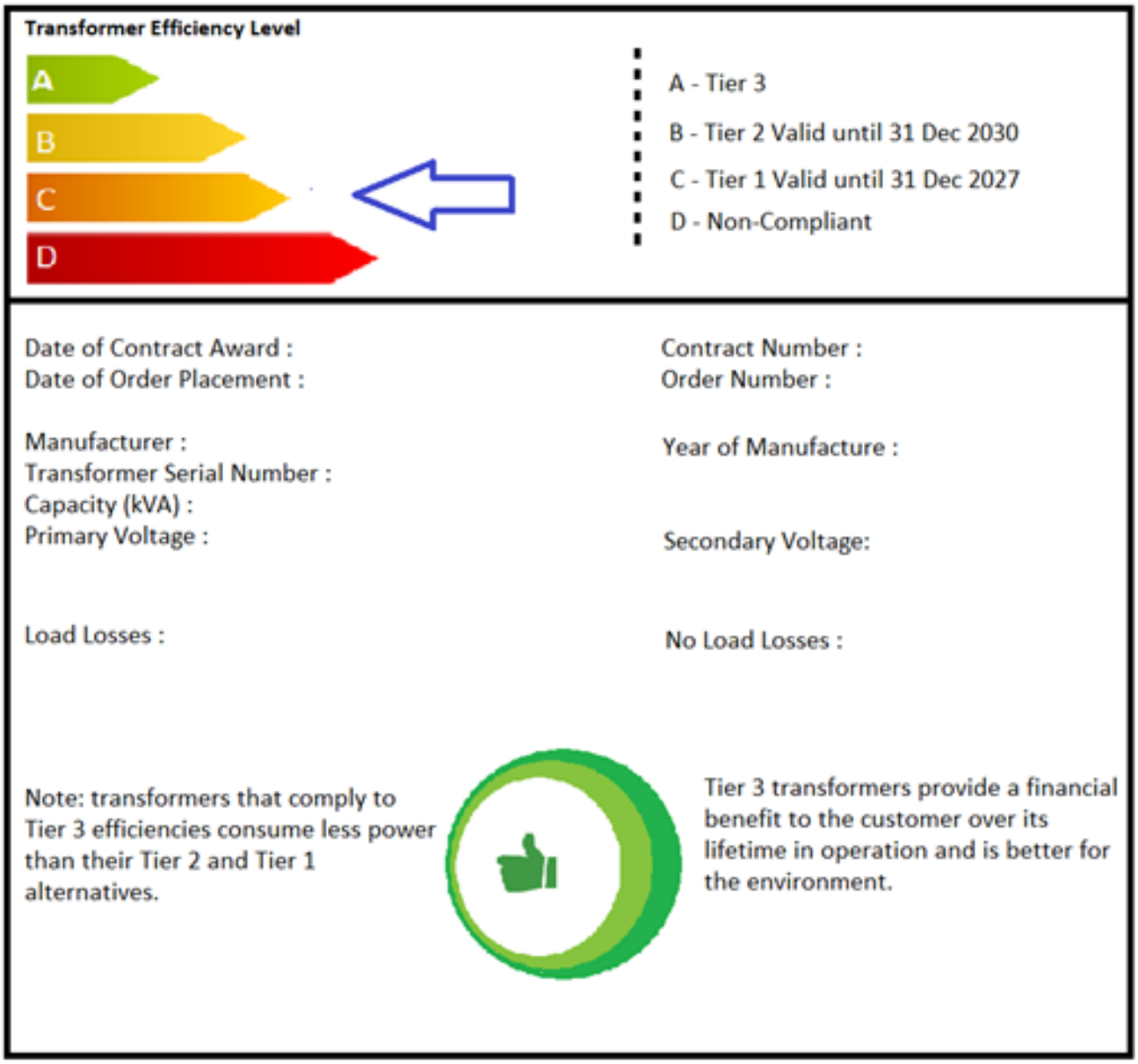

Figure 3. Distribution Transformer Energy Label

4.2 RECOMMENDATIONS

Lesotho decided in favour of having a dedicated energy label for all distribution transformers supplied to the country. The label conforms to the requirements of the Regional Standard for Efficiency of Distribution Transformers in 7 SADC countries [9] and the National Standard for Efficiency of Distribution Transformers in Lesotho [8].

The label is included in the National Standard for Efficiency of Distribution Transformers in Lesotho [8] as a mandatory requirement due to the simplicity and ease of interpretation of the label, when compared to the data

provided on the transformer rating plate. This will be of great benefit to non-technical staff such as those working for the authorities.

It is recommended that:

- The requirement for labelling be communicated clearly in tender briefings
- The National Standard for Efficiency of Distribution Transformers in Lesotho [8] be supplied with every request for quotation, or with the mandatory documentation issued with transformer tenders
- Purchasers of transformers state clearly that the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] take precedent over all other specifications used in the tender/purchase.
- The label be included as a mandatory requirement in the Technical Schedules, A and B - The technical schedules are used to evaluate the technical suitability of bidders. By including the label as a mandatory requirement in the technical schedules, bidders are obliged to provide an energy label as part of their offer or risk being disqualified from the bidding process.

Note: The Department of Energy in Lesotho will be the custodian of the label as decided by the Policy Working Group.

4.3 **ACTIONS**

The draft label was developed together with the national stakeholders in Lesotho, including the technical committees and the policy working groups. The label conforms to the requirements of the regional (SADC) standard for transformer efficiency and the Lesotho National Standard for Transformer Efficiency and is included in the Lesotho National Transformer Efficiency Standard as a mandatory requirement due to the simplicity and ease of interpretation of the label, when compared to the data provided on the transformer rating plate.

While the content of a general layout of the label has been agreed upon, Lesotho reserves the right to make cosmetic changes in line with the image of the country.

The action plan for the implementation of the energy label is thus as presented in Table 6.

Table 6: Action Plan of Implementation for the Lesotho Energy Label

Action	Responsibility	Timeline
Finalise label design. The technical parameters of the label have been accepted and was included in the National Standard for Efficiency of Distribution Transformers in Lesotho [8], which completed the public consultation project and was finalised in November 2022. The cosmetic design of the label requires attention and should be amended to include official logos and colours in line with the requirements of Lesotho.	DoE	November 2022
Provide energy label for the consumer awareness campaign. The technical contents of the label provide a snapshot of the implementation of the MEPS and may be of use/interest during awareness campaigns.	DoE	January 2022
Maintain Energy Label and perform annual reviews. It is important that label be amended in the future in accordance with any improvements in the MEPS that may be possible due to the evolution of technology in the engineering sector.	DoE/LSI	Ongoing

5 MV&E – Key Implementation Points

5.1 CONTEXT

At this point of the project the National Standard for Efficiency of Distribution Transformers in Lesotho [8] has been accepted by the policy working group and technical committee. The National Standard for Efficiency of Distribution Transformers in Lesotho [8] is currently out for public consultation, which was due to conclude in October 2022. At present, we are waiting on feedback on the finalisation of the standard from the LSI as no comments or objections were received on the standard to date. The National Standard for Efficiency of Distribution Transformers in Lesotho [8] also caters on a proposed energy label that has been drafted as part of the project and is a mandatory requirement of the standard [8]. These aspects are therefore ready to be put into practice. For this to be done effectively a well-planned, supported, systematic Monitoring, Verification and Enforcement (MV&E) framework is required.

For the MEPS and the energy label to be successfully implemented, a well-defined, planned and actioned MV&E plan is crucial. Through the MV&E plan the manner of implementation of the standard and the associated label is outlined. Effectively an action plan is developed. The proposed MV&E plan in Lesotho is one that will focus on implementation of the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. This will create a framework for compliance and ensure that all players in the market are subjected to the same requirements. It will also provide a mechanism for market surveillance and for handling non-compliances. Through having such structures, it is likely that there will be substantial levels of compliance in the market. Having such a system is often beneficial for those market players that are looking to comply and that aim to sell energy efficient products. It is therefore beneficial to such companies and if the MV&E structures are implemented, it is primarily a negative to the non-compliant companies and those that are looking to bring in inefficient, cheap alternatives. The market thus becomes partly self-governing in such a setup as it is suited to compliance. Once such a system is established it also lends itself to continuous improvement. The MEPS in Lesotho is set to increase in 2026, as set out by the National Standard for Efficiency of Distribution Transformers in Lesotho [8] in conjunction with the Regional Standard for Efficiency of Distribution Transformers in 7 SADC Countries [9]. Furthermore, through public awareness (the implementation of which is part of the MV&E plan) the average consumer will demand higher efficiencies and market forces dictate that these will come as a result of manufacturer's improvements and will eventually lead to increased efficiencies and quality of distribution transformers in Lesotho.

There are therefore 3 aspects to the MV&E plan. These 3 aspects are extremely important, and each has its own role within the framework. To successfully implement the MEPS, a well-defined, planned and actioned MV&E plan is crucial. Through the MV&E plan, the manner of implementation of the standard and the associated label is outlined. The proposed MV&E plan in Lesotho is one that will focus on implementation utilising the structures that are already existing as part of the distribution transformer procurement process. This will create a framework for compliance and ensure that all players in the market are subjected to the same requirements. It will also provide a mechanism for market surveillance and for handling non-compliances. These structures

will ensure that transformer manufacturers comply with the requirements of National Standard for Efficiency of Distribution Transformers in Lesotho [8] as they risk being excluded from transformer tenders if they don't.

There are 3 aspects to the MV&E plan:

- *Monitoring* –Monitoring is the process of checking the energy efficiency of distribution transformers by taking note of the no-load and load losses of transformers designed and manufactured for use in Lesotho. The second, critical role of monitoring is to perform checks on project implementation at various intervals. These checks are performed not just on the overall project but also at predetermined inspection points such as from the transformer schedules (supplier offer), the final electrical design of the transformer (after order/tender award), the transformer test report (issued for every transformer as per international and local specifications and, via inspections of the transformer and its energy label at ports of entry.

- *Verification* – this is the process of checking whether the product performs as it is required by the standard and the regulation. This includes the witnessing the electrical testing of random randoms at the manufacturers facility, testing at accredited third-party laboratories to compare to the transformer manufacturers test results and random testing of delivered transformers at the property of the customer.

- *Enforcement* – this is the process of ensuring that there is compliance with the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8], and thus the contractual terms for purchase of transformers. The actions to be taken against those that are non-compliant are stipulated in the plan. Effectively, it is important to set up the rules of operations and to set up structures for these rules to be implemented but it is equally critical for the rules to be enforced and for the consequences of not complying with those rules to also be enforced.

The upcoming sections of this report outline the final recommendations for the MV&E plan and describe the action plan has been developed to aid implementation. The responsibilities assigned to various stakeholders within the project are highlighted. Additionally, the funding required for a thorough M, V & E program is budgeted for. A detailed breakdown of the budget is available in the National Policy Roadmap.

5.2 GOALS AND OBJECTIVES

The main aim of developing the National Standard for Efficiency of Distribution Transformers in Lesotho [8] was to ensure that any transformers imported into the country meet the minimum requirements for energy efficiency. This will ensure that Lesotho does not incur additional costs from the purchase or generation of more energy than necessary due to transformer losses greater than those stipulated by the MEPS. The environmental impact of importing or generating energy is also reduced.

5.2.1 MONITORING OF TRANSFORMER EFFICIENCY IN LESOTHO

Whether as part of a large tender (contract) or for isolated purchase, the process for monitoring of transformer parameters already exists within the procurement process.

- ***The first opportunity to monitor transformer efficiency*** is at the bid stage. When a transformer is required, the customer requests a quote for the transformer based on the specification that is being used to stipulate the functional requirements of the transformer. Going forward, entities purchasing transformers for use in Lesotho will stipulate that the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] take precedence over any other functional specification. Suppliers are required to declare the no-load and load losses in their bid. The customer will evaluate the offer and determine suitability of the transformer based on among other aspects, the compliance to the MEPS. The no-load and load losses declared at this stage of the process will also be used for the calculation of the total cost of ownership.

- Once a bidder is successful with an offer, a detailed transformer design is produced. The customer must insist on being informed of the no-load and load losses of the transformer after the detailed design is completed. ***This is the second opportunity for monitoring transformer efficiency during the procurement process***. The no-load and load losses as calculated from detailed design should not exceed that of the initial bid as it would compromise the procurement process that was based on the total cost of ownership of the transformer. Should the losses exceed that declared during the bid stage but remain with the MEPS, penalties in line with the capitalised cost of losses should be applied. Should the losses exceed that declared during the bid stage, and exceed the MEPS, then the order should be cancelled.

- The ***third opportunity for monitoring transformer efficiency is during the completion of factory tests after the transformer is manufactured.*** It is a requirement of the IEC and SANS [3][4][5] specifications for every transformer to be tested upon manufacture and a test report produced and filed for every transformer. This test report is readily available to the customer and declares the no-load and load losses as per the test results. Should the losses exceed that declared during the bid stage but remain with the MEPS, penalties in line with the capitalised cost of losses should be applied. Should the losses exceed that declared during the bid stage, and exceed the MEPS, then the order should be cancelled.

- The ***fourth opportunity for monitoring transformer efficiency is during the inspection of the transformer at the port of entry.*** Officials representing the Ports Authority must inspect transformers entering the borders of Lesotho and determine whether the losses declared on the energy label comply with the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. Transformers that do not comply must be quarantined. Contracts for the purchasing of Transformers must clearly state that the complete responsibility (and costs) for non-compliant transformers lie with the supplier, and that the onus is on the supplier to collect the non-compliant transformer from the quarantine.

5.2.2 VERIFICATION OF TRANSFORMER LOSSES

Verification of the no-load and load losses of transformers can only be executed via electrical testing of the transformer. There are opportunities to conduct verification exercises during the manufacture of the transformer and even after the customer has taken delivery.

- The ***first opportunity for verification of the transformer losses is during the factory acceptance testing of the transformer after manufacturing.*** It is common for the customer to witness the testing of the first transformer of a particular design. In this process, a suitably qualified representative of the customer observes the no-load and load loss tests, conducted at the supplier's premises, on the transformer to determine whether there is a correlation with the bid offer the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. Should the losses exceed that declared during the bid stage but remain within the MEPS, penalties in line with the capitalised cost of losses should be applied. Should the losses exceed that declared during the bid stage, and exceed the MEPS, then the order should be cancelled.

- After taking delivery of the transformer, the customer may also conduct electrical tests on the transformer to verify the no-load and load losses of the transformer. This is the ***second opportunity for verification of the transformer losses.*** The customer may then decide on the penalties to be applied for non-compliant transformers. Should the losses exceed that declared during the bid stage but remain within the MEPS, penalties in line with the capitalised cost of losses should be applied. Should the losses exceed that declared during the bid stage, and exceed the MEPS, then the transformer must be quarantined. Contracts for the purchasing of Transformers must clearly state that the complete responsibility (and costs) for non-compliant transformers lie with the supplier, and that the onus is on the supplier to collect the non-compliant transformer from quarantine.

- The ***third opportunity for verification of the transformer losses is available via the testing of the transformer at a neutral third-party, accredited laboratory. The customer may choose to have a random transformer transported and tested at an accredited test facility. The customer and supplier can be present to witness the tests.*** Should the losses exceed that declared during the bid stage but remain within the MEPS, penalties in line with the capitalised cost of losses should be applied. Should the losses exceed that declared during the bid stage, and exceed the MEPS, then the transformer must be quarantined. Contracts for the purchasing of Transformers must clearly state that the complete responsibility (and costs) for non-compliant transformers lie with the supplier, and that the onus is on the supplier to collect the non-compliant transformer from quarantine.

5.2.3 ENFORCEMENT OF THE MEPS

The Monitoring and Verification processes will highlight any non-compliance with respect to the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. It is imperative that the recourse for non-compliance is clearly stated at the bid stage and during the contracting phase of the procurement of transformers, as provided for in national engineering contracts. To enforce the MEPS, the customer may:

- Impose penalties in cases where the losses exceed those declared at bid stage but remain within the requirements of the MEPS. The penalties should be in line with the capitalised cost of losses.
- Cancel the order in cases where the calculated losses at design stage, or the tested losses post manufacturing, exceed the losses declared during the bid stage as well as exceed the MEPS. The supplier should be issued with a non-conformance and may be blacklisted should the deviation be deemed to be intentional.
- Quarantine the transformer in cases where the transformer delivered to the customer is tested and found to be non-compliant. The responsibility for the replacement of the transformer lies with the supplier. The engineering contract placed with the supplier must clearly state that the onus and costs for the collection and replacement of the transformer lies with the supplier.

Note: It is advisable that the customer catalogue non-conformances per supplier. This will assist in the analysis of suppliers and will aid future contracting. (Penalties and recourses for future contracts may be amended based on the lessons learned).

5.3 MEASURES AND ACTIONS

For the MV & E process to function, it is important that engineering contracts state clearly:

- The requirement for compliance with the National Standard for Efficiency of Distribution Transformers in Lesotho [8] (MEPS and Labelling).
- The points at which the no-load and load losses are to be declared for monitoring.
- The points at which verification of the no-load and load losses may be executed.
- The implications for non-compliance of the MEPS as set out by the enforcement guidelines described in 5.2 above.
- The responsibility for collection and replacement of non-compliant transformers.

It is important to include these requirements in the engineering contracts, as losses are regarded at a technical parameter. Having these requirements included in engineering contracts provides a framework that allows the customer to enforce the MEPS and penalties for non-compliance.

The responsibilities within the Lesotho state owned entities lie with the following stakeholders:

- RSL – Inspection of transformers at ports. The inspectors will record information provided on the energy label to determine whether the losses declared by the supplier are in line with the MEPS stipulated by the National Standard for Efficiency of Distribution Transformers in Lesotho [8].
- LEC – Monitoring and Verification of transformer losses during the procurement process of the transformers. The LEC will be responsible for monitoring the transformer losses at the bid stage, after the final detailed electrical design and after the transformer is manufactured via the analysis of the test certificates issued post factory acceptance tests. The LEC are responsible for verification of the losses. Verification can be performed by witnessing the factory acceptance tests, having the transformers tested by the LEC on-site and comparing the results to the manufacturer's test reports, or by having a third-party test random transformers.
- LSI – Development and maintenance of the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. With the advance in technology, it is possible that transformer efficiency can be improved upon in the future. As the custodian of the National Standard for Efficiency of Distribution Transformers in Lesotho [8], the LSI will be responsible for improving on the MEPS when the need arises.

Note: It is advisable that the customer catalogue non-conformances per supplier, whether for non-compliance with the MEPS or other issues. This will assist in the analysis of suppliers and will aid future contracting. (Penalties and recourses for future contracts may be amended based on the lessons learned).

In order to successfully implement the project a number of actions require implementation. An action plan has been developed as part of the project. Based on that action plan an estimated cost has been extracted, which can be seen in Table 7 below.

Table 7: Actions, Responsibility, Budget Requirements and Timelines for MV&E

Activity	Responsibility	Budget (LZL)	Timeline (months)
Standard Distribution	LSI	20,000.00	0 - 3
Internal Training	LSI, LEC, DoE, RSL, LNDC	1,100,000.00	0 - 3
RSL Inspectors at Borders	RSL	3,000,000.00	3 - 6
Surveillance Inspectors	RSL	3,000,000.00	3 - 6
Dealing with Non-Compliance - Legal	DoE, LEC	1,000,000.00	6 - 12
Warehousing	LEC	500,000.00	0 - 3
Laboratory Testing of Samples	LEC	3,500,000.00	6 - 12
Monitoring	DoE	1,200,000.00	12 - 18
	Total (LSL)	**13,320,000.00**	
	Total USD (Rate $1 = LSL18)	**740,000.00**	

6 Consumer Awareness

6.1 CONTEXT

The consumer awareness campaign is a critical to the long-term goals, and sustainability of the energy efficiency project. For the energy efficiency initiative to be successful it requires the support of all stakeholders, including the consumers of the product. Even though the National Standard for Efficiency of Distribution Transformers in Lesotho [8] will most likely be accepted after public consultation, it is important to reiterate the MEPS and the drive for improved energy efficiency within Lesotho.

The consumer awareness campaign also highlights Lesotho's pursuit of HEPS while adopting a Total Cost of Ownership approach to transformer procurement, rather than the lowest capital cost of a transformer.

Unlike refrigerators, distribution transformers are not purchased by the general public, and its use is limited to utility and industrial application. The consumers of distribution transformers have a level of technical expertise that allows them to understand the impact of lower transformer losses on energy costs (generating and imports), productivity, carbon emissions etc.

A successful implementation of the project requires both supply-side and demand-side interventions. The former is executed via the MEPS as stipulated by National Standard for Efficiency of Distribution Transformers in Lesotho [8], whereas the latter is dependent on education and the changing of both the purchase and energy usage, behaviour.

An example of an effective awareness campaign and the steps required is presented in Figure 4 below.

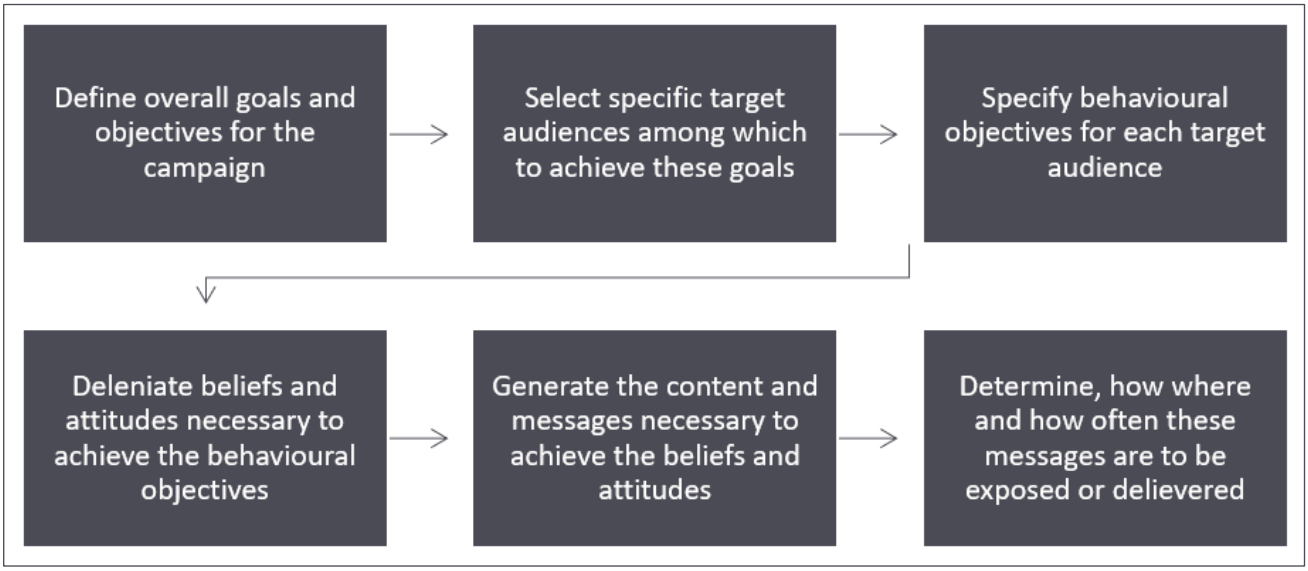

Figure 4: Awareness Raising Campaign Planning Process (adapted from Donovan & Henley 2010)

In alignment with the processes listed in Figure 4, the steps required to implement a thorough and effective consumer awareness campaign are:

1. Stakeholder analysis
2. Development/identification of targeted audiences
3. Identification of objectives of the consumer awareness campaign
4. Development of messages for the targeted audiences
5. Identification of communication tools to be used for the specific audiences
6. The implementation plan of the consumer awareness campaign
7. The monitoring and evaluation plan of the consumer awareness campaign
8. The overall draft budget for the consumer awareness campaign

Based on the process described above the following recommendations are prepared for Lesotho.

6.2 RECOMMENDATIONS

Stakeholder Analysis

Based on the market assessment the following entities have been identified as the most important stakeholders for distribution transformers in Lesotho.

The roles of the different stakeholders in the development of the policy and MEPS are listed in Table 8 below.

Table 8: Key Stakeholders for the Consumer Awareness Campaign for Distribution Transformers in Lesotho

Entity	Role in Relation to the MEPS Project	Responsibility in Relation to the Awareness Raising
Ministry of Energy and Meteorology	• Driver of the MEPS development and implementation • Formation of energy related initiatives	• Campaign champion (provision of vision and action plan, coordination of work of all entities involved)
Ministry of Communications, Science and Technology	• The support ministry to the Ministry of Energy in this project • Can facilitate governmental support for legislation and implementation support	• Relevant departments: Department of Information, Postal Services; Lesotho national Broadcasting Services (radio and TV) • Develop and maintain printed materials for the campaign. • The ministry will work together with local consultants, Experts in multi-media communication, for development and implementation of messages and infomercials • Develop radio and TV advertisements and infomercials
Lesotho Electricity Company	• The main buyer and user of distribution transformers. • The importer and seller of electricity and as such a key to the implementation of the project and	• Electricity usage data source

Entity	Role in Relation to the MEPS Project	Responsibility in Relation to the Awareness Raising
	one of the project's biggest beneficiaries	
Lesotho Electricity Generation Company	• Newly formed organisation • Responsible for new electricity generation within the country	• Electricity usage data source • Targeted audience for knowledge on transformers MEPS
Lesotho Central Bank	• Responsible for the governance of the financial sector and would be able to support initiatives that finance the implementation of the project from a regulatory perspective	• Provision of funding for the campaign • Acting as an advisor in in matters of financing
Revenue Services Lesotho	• Inspection/approval of imports of transformers into the country	• Targeted audience for knowledge on transformer MEPS
Lesotho Standards Institute	• Information on standards of transformers	• Provision of information and fact on MEPS for transformers • Development of training material in partnership with Energy Research Centre • Conducting training workshops for interested parties with Energy Research Centre
The University of Lesotho (especially the Energy Research Centre)	• Perform relevant research that informs national energy policy for sustainable development	• Provision of technical support in Monitoring an Evaluation of the campaign • Collecting data during and after campaign • Analysis of key metrics to inform further changes required to the campaign • Development of training material in partnership with Lesotho Institute Standards • Conducting training workshops for interested parties with Lesotho Institute Standards
Electrical contractors	• Installers of transformers	• Targeted audience for transformer MEPS
Private businesses using transformers	• Purchasers/end-users of transformers	• Targeted audience for changes in procurement and use behaviour of distribution transformers
The Lesotho Industrial Development Corporation	• Owner of distribution transformers	• Targeted audience for changes in procurement and use behaviour of distribution transformers
Lesotho Electricity Company	• The main buyer and user of distribution transformers. • The importer and seller of electricity and as such a key to the implementation of the project and one of the project's biggest beneficiaries	• Targeted audience for knowledge on transformer MEPS • Targeted audience for changes in procurement and use behaviour of distribution transformers
Lesotho Electricity Generation Company	• Newly formed organisation • Responsible for new electricity generation within the country	• Targeted audience for knowledge on transformers MEPS
Revenue Services Lesotho	• Inspection/approval of imports of transformers into the country	• Targeted audience for knowledge on transformer MEPS and customs approvals
Financial Institutions	• Lenders supporting the implementing of energy efficient project	• Targeted audience for knowledge about transformer MEPS

It is then important to identify the target audiences as related to the distribution transformer MEPS, HEPS and Energy Label. These are presented in Table 9 below.

Target Audiences

Table 9: Target Audiences for the Lesotho Distribution Transformer Consumer Awareness Campaign

Entity	Role in Relation to the MEPS project	Responsibility in Relation to the Awareness Raising
Utilities and owners of distribution transformers	Users/operators of distribution transformers	• Targeted audience for change in purchasing requirements (TCO).
Importers and resellers of transformers	Suppliers of Distribution transformers to third party users	• Targeted audience for MEPS and change in purchasing methods (TCO).
Electrical contractors and installers of transformers	Electrical contractors that may install transformers on larger distribution network.	• Targeted audience for knowledge about MEPS • Means of communicating the information/educating end-users
Educational Institutions	Research and development in the energy sector	• Targeted audience for education regarding energy efficiency and research in the energy sector
Engineering Bodies and Institutions	Dissemination of information regarding MEPS to engineers and technicians subscribing to the institute	• Targeted audience for knowledge about MEPS • Means of communicating the information/educating end-users
Financial Institutions	Lenders supporting the implementing of energy efficient appliances	• Targeted audience for knowledge about refrigerator MEPS
Revenue Services Lesotho	Inspection/approval of imports of refrigerators into the country	• Targeted audience for knowledge on refrigerator MEPS and customs approvals. Key to MV& E

Objectives and Goals

The main goal of public awareness campaign for distribution transformers is to:

Raise awareness among all stakeholders involved in the broader supply chain of distribution transformers with respect to the purchasing and operation of the transformers in accordance with the National Standard for Efficiency of Distribution Transformers in Lesotho [8].

Considering the above goal, Table 9 below outlines the targeted audiences and the key objectives of the public awareness campaign that reflects the change desired to be achieved through it.

Table 10: Target Audiences and Objectives of Refrigerator Awareness Campaign

Targeted Audience	Key Objectives and Desired Changes
Utilities and owners of distribution transformers	Change the attitude towards the purchasing of energy efficient transformers by promoting a TCO approach to procurement as opposed to purchasing lower initial cost transformers that have higher no-load and load losses. By raising awareness of, and by enforcing the MEPS stipulated by the National Standard for Efficiency of Distribution Transformers in Lesotho [8], a high level of achievement of this goal is expected (100%).
Importers and resellers of transformers	Change the attitude towards the purchasing of energy efficient transformers by promoting a TCO approach to procurement as opposed to purchasing lower initial cost transformers that have higher no-load and load losses. By raising awareness of, and by enforcing the MEPS stipulated by the National Standard for Efficiency of Distribution Transformers in Lesotho [8], a high level of achievement of this goal is expected (100%).
Revenue Services Lesotho	Improve monitoring at the ports of entry such that MEPS are enforced, and non-compliant transformers are prevented from entering Eswatini.

Messages for the Targeted Audiences

Given the different objectives outlined in the previous section, Table 10 below lists the messages that should be promoted to achieve the desired change in knowledge and behaviour among various groups of stakeholders:

Table 11: Key Objectives and Associated Messages for the Distribution Transformer Awareness Campaign

Key Objectives and Desired Changes	Messages
Change the attitude towards energy efficiency among utilities (LEC) and industrial users of distribution transformers.	• By procuring energy efficient transformers, the required generating capacity is reduced thereby reducing the amount of energy to be generated or imported. • By utilising a TCO approach to procurement, savings can be realised from the long-term operation of transformers. In addition to direct financial savings, gains can be made with respect to carbon emissions as well.
Revenue Services Lesotho	• The new standard prevents inefficient transformers from entering Lesotho.
Achieve a high level (100%) of knowledge and understanding of energy label for distribution transformers among the port's authority, purchasers and installers of transformers.	• The energy label allows ease of differentiation between compliant and non-compliant transformers with respect to the National Standard for Efficiency of Distribution Transformers in Lesotho [8], • The energy label aids staff stationed at the ports of entry in identifying non-compliant transformers and in preventing them from entering Eswatini.
Impart knowledge regarding the new National Standard for Efficiency of Distribution Transformers in Lesotho [8] to the broader engineering sector.	• Enforcement of the MEPS and the requirement for labelling as stipulated by the National Standard for Efficiency of Distribution Transformers in Lesotho [8].

Communication Tools

The identification of the target audiences for the various messages enables us to identify specific communication tools to effectively reach those audiences. These tools are shown in Table 11 below.

Table 12: Targeted Audiences and Communication Tools for Regurgitator Awareness Campaign

Targeted Audience	Communication Tools
Utilities and owners of distribution transformers	• Seminars and technical training - (Train the trainer – dissemination of training material) • Articles and information in the Engineering Media -Magazines, Bulletins etc • Website pages of the LEC, LSI, DOE etc.
Engineering Bodies and Institutions	• Seminars and technical training - (Train the trainer – dissemination of training material) • Articles and information in the Engineering Media -Magazines, Bulletins etc • Website pages of the Tertiary Institutes and Engineering Institutions such as the technical colleges, universities and council for electrical engineers etc
Revenue Services Lesotho	• Training on energy labels and standards for transformers • Posters at ports of entry

6.3 MEASURES AND ACTION

Monitoring and Evaluation is an integral part of any project, programme or campaign. It aims to provide an insight into whether the campaign is on course to achieves objectives, which in turn allows one to adapt its execution if any gaps or challenges are identified. Table 12 provides a list of indicators that could be used to monitor the progress of the campaign and to evaluate its success after its completion.

Table 13: Monitoring and Evaluation Indicators for the Distribution Transformer Awareness Campaign

Measured Output / Outcome	Means of Gathering Data / Tools	Frequency of Data Gathering	Sample
Attitude towards energy saving	Survey (in person / telephonic)	Every quarter of the campaign starting from just before the campaign for baseline	• LEC Employees • Private Industry with installed transformers • Electrical Contractors • Importers Resellers
Achieving a high level of awareness (100%) regarding new energy efficient standard	Test/ Questionnaire for participants in the training session	After each training session	• LEC Employees • Private Industry with installed transformers • Electrical Contractors • Importers Resellers • Students of Electrical Engineering at Tertiary Institutions.
Achieving a high level of Knowledge and understanding of the energy label	Test/ Questionnaire for participants in the training session	After each training session	• Contact staff at the ports authority, utilities and private industry to determine whether they are aware of the MEPS stipulated in the National Standard for Efficiency of Distribution Transformers in Lesotho [8].
Change in procurement strategy and purchase behaviour	Survey	Every month of the campaign starting from just before the campaign for baseline	• LEC • Private Industry • Monitor whether tenders/orders for the procurement of distribution transformers employ TCO and refer to the MEPS stipulated in the National Standard for Efficiency of Distribution Transformers in Eswatini [8].
Reduced Energy consumption by the LEC	National statistics / annual reports	Annually	• LEWA

Table 14 provides an estimated budget for the distribution transformer consumer awareness programme. Distribution transformers are operated and purchased by a utilities and large industry. There consumer awareness programme is therefore much more streamlined compared to that required for refrigerators. Table 14 below lists the targeted stakeholders and the budget required to conduct an effective consumer awareness campaign

Table 14: Actions, Responsibility, Budget Requirements and Timelines for the Consumer Awareness Campaign for Distribution Transformers

Activity	Responsibility	Budget LSL	Timelines (Months)
Distribution of the National Standard	LSI	20,000.00	6. 0 - 3
Publish on Websites of various stakeholders	LSI, LEC, DoE, RSL	10,000.00	0 - 3
Print Media – Engineering magazines, bulletins printed in the engineering sector and at tertiary institutions	DoE, LEWA	20,000.00	0 - 6
Training on Energy Efficient Distribution Transformers and Total Cost of Ownership	LSI, LEC, DoE, RSL	100,000.00	0 - 12
	Total (LSL)	**150,000.00**	
	Total USD (Rate $1 = LSL 18)	**8,333.33**	

7 Financial Mechanisms

7.1 CONTEXT

Financial mechanisms are methods of accessing funding for the effective implementation of a strategy or project. In this case, financial assistance via various avenues is explored to promote a transition towards the use of more energy efficient distribution transformers in Lesotho.

Transformers are generally purchased in bulk by the key stakeholders in Lesotho and therefore require significant financial reserves and guarantees. Energy efficient distribution transformers have a higher initial cost and even though these costs are recovered by reducing the energy losses over the service life of the transformer, an additional burden is placed on the consumer at the point of purchase. The LEC obtains it's funding from the DOE, which in turn applies for funding from the government of Lesotho. The funds are generally made available via loans obtained from lending institutions such as the World Bank and the International Monetary Fund (IMF). It stands to reason that the LEC would need larger loans to cover the cost of energy efficient distribution transformers.

There are four financial mechanisms available to Lesotho to enable a transition to energy efficient distribution transformers. These mechanisms are expanded upon below.

7.2 FINANCIAL MECHANISMS FOR ENERGY EFFICIENT DISTRIBUTION TRANSFORMERS

7.2.1 REGULATORY FRAMEWORK FOR UTILITIES AND THE TOTAL COST OF OWNERSHIP MODEL FOR TRANSFORMER PROCUREMENT

The impact of losses in distribution transformers is felt throughout the electricity network. Higher losses require distribution and transmission grids to purchase greater quantities of energy, while electricity generators are required to produce a larger quantity of energy than would be required for systems with a higher energy efficiency. The costs of purchasing energy for distribution and transmission networks are therefore higher, while additional strain is placed on generation resources and equipment. In the case of Lesotho, energy is imported from South Africa and Mozambique to supplement local generation sources as there is insufficient generation capacity to meet the demand of the country. The shortage of generation capacity in South Africa therefore places the reliability of supply in Lesotho at risk. Lesotho also faces the prospect of a steep rise in tariffs from Eskom when the current energy purchasing contract expires. It is therefore in the interest of the country to pursue lower losses via energy efficient distribution transformers provided that the total life cycle cost of energy efficient transformers outweighs the higher initial cost.

Progressive regulatory frameworks aim to incentivise both customers and utilities to incorporate the benefits of lower losses in such a manner that both parties' benefit.

It is a function of the country's energy regulator, LEWA, to promote the purchase of energy efficient transformers. The price control formulars must be executed in a manner such that the LEC and industrial uses are not punished for buying more expensive but more energy efficient transformers.

Utilities and other owners/users of distribution transformers should be incentivised to use a total cost of ownership approach to transformer procurement, where losses, carbon emissions and other environmental impacts are capitalised. The LEC and other owners/users of distribution transformers in Lesotho have purchased transformers based on the lowest capital cost. A transition to a TCO model will ensure that the higher initial cost of energy efficient transformers are balanced out (and overcome) by energy savings. The incentive should operate irrespective of whether the utility is responsible for buying or generating the electricity needed to supply system losses and would apply even when MEPS are in force [12]. The Total cost of ownership is calculated by the following formular [13]:

$$TCO = IC + A \times (P_0 + P_{C0}) + B \times (P_k + P_{CS} - P_{C0}) \qquad \text{Eqn. A.1}$$

Where,

- *IC* is the initial cost of the transformer; this cost may include installation costs such as foundation and erection costs (requires a more sophisticated evaluation);
- P_0 is the no-load loss (kW) measured at the rated voltage and rated frequency, on the rated tap;
- P_k is the load loss (kW) due to the load, measured at the rated current and rated frequency on the rated tap at a reference temperature;
- P_{CS} is the total cooling power (kW) needed for operation at the rated power (including three winding operations if any) (note: this variable is set to zero for passively cooled transformer designs);
- P_{C0} is the cooling power (kW) needed for no-load operation (note: this variable is set to zero for passively cooled transformer designs);
- *A* is the cost of capitalisation of no-load losses in cost per kW including the cost of carbon emissions;
- *B* is the cost of capitalisation of the losses due to load in cost per kW including the cost of carbon emissions.

The stakeholders in Lesotho have been trained to use the TCO calculator developed during the execution of this project. As shown in section 3.5, the experiences of the state utility in South Africa, Eskom, prove that this model works in a Southern African context.

7.2.2 GUARANTEED SAVINGS MODEL VIA ENERGY SERVICES COMPANIES (ESCOS)

The guaranteed savings model is executed via Energy Services Companies (ESCOs), who play an important role in promoting energy efficiency. ESCOs provide turn-key technical solutions to build or upgrade electrical infrastructure that does not meet energy efficiency criteria. ESCO's perform energy analysis to determine the energy savings from their intervention. Performance guarantees (energy savings) based on the studies are stipulated in the contract between the customer and the ESCO. The customer secures funding for the project and is able to experience a return on investment from energy savings. The remuneration due to the ESCOs are a function of the performance contract. The added advantage of this system is that the energy performance must be monitored. Maintenance of the plant and performance audits are generally included in the contracts and ensure operational performance of the plant/system is maintained over an extended period.

7.2.3 BULK PROCUREMENT AND STANDARDISATION

The National Standard for Efficiency of Distribution Transformers in Lesotho [8] aligns with the MEPS stipulated by the Regional Standard for Efficiency of Distribution Transformers in 7 SADC countries [9]. The requirement for distribution transformers with regards to MEPS will therefore be standardised across the entire SADC (South Africa is in alignment with the MEPS via their distribution transformer standard; SANS 780, 2019 South African National Standard, Transformers [3]). There are several common suppliers, mostly based in South Africa, that service the transformer market in the SADC. These suppliers have already made the necessary adjustments in terms of manufacturing facilities and techniques required to produce higher efficiency transformers in order to service the South African Market, and the South African State-owned electricity utility, Eskom. It is therefore unlikely that any costs pertaining to infrastructure improvements and improved designs would be reflected in the initial cost of distribution transformers required by stakeholders in Lesotho. Additionally, the standardisation of the MEPS in SADC would result in greater quantities of energy efficient transformers across SADC. This in turn should result in lower costs in the procurement of core steel and conductor due to the economies of scale. The increased initial cost of distribution transformers is expected to be mitigated by these factors.

Adjustments in Manufacturing for the Production of Energy Efficient Distribution Transformers

Data obtained from the United Nations Global Trade Repository, Comtrade [1], indicates that Lesotho obtains its transformers primarily from South Africa. Transformer manufacturers in South Africa are already supplying energy efficient transformers into the South African in accordance with the requirements of SANS 780, 2019 South African National Standard, Transformers [4]. The Market Assessment Report for Distribution Transformers in Lesotho [7] indicates that the MEPS stipulated in SANS 780, 2019 South African National Standard, Transformers [4] require more energy efficient transformers that are currently being supplied into Lesotho. The costs associated with improved manufacturing facilities and techniques have therefore already

been realised and it is therefore unlikely that any costs pertaining to infrastructure improvements and improved designs would be reflected in the initial cost of distribution transformers required by stakeholders in Lesotho.

7.3 RECOMMENDATION

Financial supporting mechanisms are required in Lesotho to successfully adopt more energy efficient transformers in line with the requirements of the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. Financial support is required for the various government entities to transition to energy efficient distribution transformers. The LEC and other prospective purchasers of energy efficient transformers in Lesotho may pursue funding via the mechanisms described in section 7.2, above. There is also the possibility of accessing funding for green projects - Several of the large banks that operate in Lesotho have specific mechanisms to fund “green” projects.

8 Conclusion

As has been shown in this report the Eswatini National Project related to energy efficiency of distribution transformers has resulted in several key developments. Amongst these the most important is the development of the National Standard for Efficiency of Distribution Transformers in Lesotho [8], which has been accepted by the policy working group (PWG) and technical committee for distribution transformers and has been out for public consultation since September 2022. At present, we are waiting on feedback on the finalisation of the standard from the LSI as no comments or objections were received on the standard to date. This standard is very closely related to the Regional Standard for Efficiency of Distribution Transformers in 7 SADC Countries [9]. This standard outlines the MEPS and HEPS values for efficiency in Lesotho. Importantly the energy label has also been developed for Lesotho as part of the project and is aligned with the regional labelling requirements.

Several implementation methodologies were developed to support the MEPS and labelling requirements as set out by the National Standard for Efficiency of Distribution Transformers in Lesotho [8]. This report outlines some of the key points related to the implementation of the project. These include the consumer awareness campaign that has been developed in order to reach the various consumers and stakeholders of the project. Another important factor for the successful implementation of the project is the funding and this report outlines some of the key financial mechanisms that can be exploited in Lesotho that would enable project implementation and purchasing of more energy efficient distribution transformers. Furthermore, the MV &E of the project has been outlined in detail. All these reports have been completed as separate deliverables. However, the most important aspects to the successful implementation of the project in Lesotho are outlined in this report. Importantly, the mechanisms for the implementation of the regulations, both in terms of border controls of imports and market surveillance related to compliance verification have been discussed and developed. Furthermore, the budget for the implementation of the project for the period of the next 3 years has been developed.

Therefore, this National Resource Plan summarises the development of the National Standard for Efficiency of Distribution Transformers in Lesotho [8] and the energy label, their alignment with the regional standard and maps out plans for the implementation of the standard and accompanying regulations.

9 References

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[8] National Standard for Efficiency of Distribution Transformers in Lesotho.

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