

National Policy Roadmap: Plan for Uptake of Higher Efficiency Distribution Transformers.

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PARTNERS



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Abbreviations & Acronyms

CTCN	Climate Technology Centre and Network
EAC	East African Community
EE	Energy Efficiency
EPRA	Energy and Petroleum Regulatory Authority
EU	European Union
GHG	Green House Gases
GIB	Green Issues Botswana
GWP	Global warming potential
ISO	International Standards Organization
MEPS	Minimum Energy Performance Standards
MVE	Monitoring, verification and enforcement
NEES	National Energy Efficiency Strategy
NRCS	National Regulator for Compulsory Specifications
ODP	Ozone depletion potential
S&L	Standards and Labelling
SA	South Africa
SADC	Southern African Development Community
TWh	Terrawatt hours
U4E	United for Efficiency
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

Executive Summary

The project ‘*Leapfrogging to Energy Efficient Appliances and Equipment in Botswana through Regulatory and Financing Mechanisms*’ will result in Botswana having a regulatory framework, agreed upon MEPS and labelling scheme for Distribution Transformers. A detailed market assessment conducted in the initial stages of the project indicated that in Botswana, distribution transformers are generally procured by specialized companies such as the utility, BPC, and a few mining companies.

As a developing economy in Sub-Saharan Africa, the demand for transformers in Botswana is expected to continue to grow in the coming years with an increase in energy demand. It is therefore of significance to increase the energy performance of distribution transformers to work towards the dual goal of increasing both energy and CO₂ savings in Botswana. Reliable estimations using the transformer stock model for Botswana until 2040 indicates that the adoption of the proposed MEPS for Distribution Transformers holds the potential to lead to a **cumulative** energy savings up to 2040 of **1,025 GWh** and CO₂ savings of **1,209ktCO₂**

Further, it is well understood that transformers are expensive to purchase, but they are even more expensive to own due to their long, life expectancy of between 30 and 50 years. As a result of this long period of service, the cumulative operating losses often end up costing the utility much more than the initial cost of the transformer.

These were some of the key considerations that led to the development of this national policy roadmap to provide a pathway for Botswana to transition to higher efficiency distribution transformers. This policy roadmap plan provides a brief overview of the various components required for a successful implementation of the standards and labelling program for Distribution Transformers in Botswana.

This document lays out the steps that Botswana would take to implement the proposed distribution transformer minimum energy performance standards (MEPS). While **MEPS** give a good ‘push’ to the market, the Total Cost of Ownership (**TCO**) methodology offers a ‘pull’ for the market by providing the utility with a mechanism to value future losses while procuring transformers.

Once the MEPS are adopted, the road map also provides guidance on how Botswana can check the market for compliance using a Monitoring, Verification and Enforcement framework. A financing mechanism has also been proposed to present the various options that the agencies involved could leverage to raise the funds they need to successfully implement the roadmap. Finally, an implementation schedule and an estimated budget have been included to provide policy makers in Botswana with insight on the resources required to successfully transition. These components work together as they are quick and easy to implement and offer the potential to fast-track Botswana into higher efficiency DTs.

The main recommendations from this report are:

- The Ministry of Minerals and Energy to initiate the formal process to include the Energy Efficiency project for distribution transformers into the National Development Plan 12 for the project to be aligned with the NDP 12 goals and shortlisted as a funding priority for the government. By working closely with the Ministry of Finance, the Department of Energy could ensure that this project is included in the budget planning exercise as a priority for the next financial year.
- As the largest importer of distribution transformers, BPC should take the lead in adoption of the proposed MEPS levels with the support of BERA as the verification agency.
- BPC should incorporate the use of the Total Cost of Ownership (TCO) tool to further enhance their procurement practice for Distribution Transformers.
- The MEPS level should be reviewed after the proposed 7-year period to update them and sustain the market transformation.
- The MEPS are currently being developed as voluntary but should be transitioned to mandatory to empower regulators to monitor for compliance.
- Conduct a comprehensive consumer awareness program that sensitizes the public on the new labels for distribution transformers

1. Introduction

1.1. Project Background

The project *'Leapfrogging to Energy Efficient Appliances and Equipment in Botswana through Regulatory and Financing Mechanisms'* will result in Botswana having a regulatory framework, agreed MEPS and labelling scheme for Distribution Transformers. CLASP was contracted as the implementing Network partner by UNEP through the Climate Technology Centre and Network (CTCN) the implementing institution and United for Efficiency (U4E) as the technical partner of the project.

The main objectives of this project are to:

- Develop mandatory minimum energy performance standards and propose labeling schemes
- Create a national policy roadmap and enabling environment for the implementation of the standards and labels
- Propose appropriate financing mechanisms to accelerate deployment distribution transformers; and
- Strengthen the national capacity for Botswana to develop standards and labels for other appliances in future.

1.2. The Policy Roadmap Plan

This policy roadmap plan provides a summary of the various components required for a successful implementation of the standards and labelling program for Distribution Transformers in Botswana. It lays out the steps that Botswana will take to implement the various components, the agencies involved as well as the time it would take to successfully adopt the recommendations proposed. This information is structured in the following chapters.

- Chapter 1: Introduces the project and the objective of the policy roadmap plan for DTs.
- Chapter 2: Highlights the national test standards and MEPS for distribution transformers. These form the foundation upon which the enforcement framework is built.
- Chapter 3: Proposes the DT label and related consumer awareness. In Botswana since most DTs are procured and used by BPC, this section indicates the training required for BPC officers in order to understand the transition to higher efficiency DTs.
- Chapter 4: Details the MV&E framework that would be suitable to support the adoption of higher efficiency transformers by BPC and mining companies. It also describes the role of various agencies identified for the framework to be successful.
- Chapter 5: Provides an overview of the financing mechanisms available for the Government of Botswana and BPC to leverage to support the procurement of higher efficiency DTs.
- Chapter 6: Provides a proposal for an implementation schedule as well as an estimated budget for Botswana to adopt this roadmap for DTs.

2. Distribution Transformer National Test Standards and MEPS.

2.1. Overview of Standards

The electrification rate in Botswana is among the highest in Sub-Saharan Africa with 60.7% of the population having access to electricity. Electricity is regulated through the Botswana Energy Regulation Authority (BERA) Act of 2016 in conjunction with the Electricity Supply Act and the Botswana Power Corporation Act. These acts cover the generation, transmission, distribution and sale of electricity.

Distribution transformer (DT) demand is driven by the increase of electricity demand and the projections shared by the national utility Botswana Power Corporation (BPC) show an expected rise in demand over the next few years. All distribution transformers in Botswana are procured, installed, operated and maintained by the BPC. There is no private ownership of DTs and no private mini-grids exist in Botswana.

In the preparation of this roadmap, BPC officials were engaged consistently from the data collection process to the design of the MEPS and thereafter in the discussion on how they could support the transition to higher efficiency DTs through procurement practices leveraging on the Total Cost of Ownership (TCO) model.

Section 2.2 below highlights the recommendations made to Botswana for the DT test standards and MEPS.

2.2. Standards Recommendations

2.2.1. National Test Standards

Botswana has an existing standard for distribution transformers that has been in place since 2013.

BOS 563:2013 was adapted from IEC 60076 for Botswana conditions. It also borrows from SANS 780:2009. This Standard covers standard loss requirements as well as requirements on mechanical construction and functional performance since these requirements are not primarily related to energy performance.

For energy performance, a new test standard was proposed and recommended for adoption by the Technical Committee. The new proposed standard was recommended as:

FDS 563: 2021 – Specifies requirements for three-phase and single-phase oil immersed transformers up to and including 3150KVA.

This was proposed together with the MEPS covered in detail in section 2.1.2 below.

2.2.2. Minimum Energy Performance Standards

Minimum energy performance standards (MEPS) are the cornerstone of market transformation programs.

The roadmap for Botswana proposes that Botswana adopt the high MEPS (Level 2) as defined in IEC TS 60076-20 because they are an import-based market. It proposes a phased three tier approach for smoother implementation and to keep up with technological and market developments:

- **Tier 1**- this aligned with SANS 780:2021 of South Africa. It defines the maximum loss levels accepted in South Africa and is appropriate for Botswana as a lot of the imports come from or via South Africa and creating a big market for similar transformers, driving costs down. The efficiency tables in SANS 780 were updated in 2019, and the standard was slightly updated (without changing the efficiency tables) in 2021, thus the latest version is SANS 780:2021 however the levels have been around a few years already. It is therefore proposed that Botswana adopts this as Tier 1. The ambition of this level at 50% loading is nearly identical to IEC TS 60076-20 Tier 1, thus **in adopting the levels in the South African standard, Botswana will essentially be moving to IEC Tier 1 as the same time.**
- **Tier 2** – interim step: It was considered that a step from SANS 780/IEC Tier 1 to IEC Tier 2 might be too great, so we

have created an interim step called Tier 2 which is simply the average of the SANS 780 standard (Tier 1) and the IEC Tier 2 standard (Tier 3). This interim step helps to save more energy and keeps the focus in the sector on investing in reducing losses. **This is proposed to be adopted in four years.**

- **Tier 3** – aligned with IEC: SANS 780:2021 only provides one set of efficiency levels, so there is no higher tier. However, IEC TS 60076-20 does have a Tier 2, and the proposal is that this more ambitious level be set as Tier 3 for Botswana. This ensures that Botswana eventually transitions to the international high efficiency standard and companies are given adequate time to procure new equipment and train staff. Setting this level out in the future gives the planning horizon suppliers and customers need so they are prepared. **This is to be adopted in seven years.**
- In addition, a single-phase table from 5 kVA to 100 kVA is included. These levels are based on analysis done by the Super-Efficient Equipment and Appliance Deployment (SEAD) program. They correspond to SEAD Tiers 2, 3 and 4. A comparison of (for example) a 100 kVA single phase to a 315 kVA three phase, shows that the efficiency levels are very similar at all three levels.

This Standard provides a technical standard rating according with IEC practices, which have been adopted by the Southern African Development Community for Distribution Transformers. It also aligns with the recommendations for MEPS for the Southern African region by the U4E.

2.2.2.1. Energy Performance Requirements

Transformers in the scope of this regulation shall comply with the maximum allowed load and no-load losses values set out in the following tables.

Maximum allowable losses rated powers that fall in between the given values shall be determined through linear interpolation.

(a) Three-phase liquid-immersed distribution transformers

i. MEPS Level 1

This is to be effective within one year of this standard being published as the Botswana Minimum Energy Performance Standard for Distribution Transformers.

Rated Power, IEC 60076-1	Maximum Load Losses	Maximum No-Load Losses	Percent Efficiency at 50% load
(kVA)	(watts)	(watts)	(%)
25	520	70	98.40%
50	880	110	98.68%
100	1500	190	98.87%
160	2200	270	98.98%
250	3100	380	99.08%
315	3600	450	99.14%
400	4400	540	99.18%
500	5200	630	99.23%
630	6200	750	99.27%
800	7500	900	99.31%
1000	8900	1070	99.34%
1250	10500	1260	99.38%

1600	12800	1520	99.41%
2000	15100	1790	99.44%
2500	18000	2120	99.47%
3150	21500	2520	99.50%

TABLE 1: MEPS LEVEL 1 FOR 3 PHASE LIQUID IMMERSERD TRANSFORMERS

ii. MEPS Level 2

This is to be effective within four years of this standard being gazetted as the Botswana Minimum Energy Performance Standard for Distribution Transformers. (Target Year 2027)

Rated Power, IEC 60076-1	Maximum Load Losses	Maximum No-Load Losses	Percent Efficiency at 50% load
(kVA)	(watts)	(watts)	(%)
25	460	56	98.63%
50	782.5	92	98.85%
100	1340	156	99.02%
160	1930	225	99.12%
250	2715	320	99.20%
315	3200	387	99.25%
400	3825	463.5	99.29%
500	4550	544.5	99.33%
630	5400	645	99.37%
800	6750	742.5	99.39%
1000	8200	855	99.42%
1250	9650	1025	99.45%
1600	11800	1247.5	99.48%
2000	14050	1460	99.50%
2500	16750	1720	99.53%
3150	20250	2075	99.55%

TABLE 2: MEPS LEVEL 2 FOR 3-PHASE LIQUID IMMERSERD TRANSFORMERS

iii. MEPS Level 3

This is to be effective within seven years of this standard being gazetted as the Botswana Minimum Energy Performance Standard for Distribution Transformers.

Rated Power, IEC 60076-1	Maximum Load Losses	Maximum No-Load Losses	Percent Efficiency at 50% load
(kVA)	(watts)	(watts)	(%)
25	400	42	98.86%
50	685	74	99.02%
100	1180	122	99.17%
160	1660	180	99.26%
250	2330	260	99.33%

315	2800	324	99.35%
400	3250	387	99.40%
500	3900	459	99.43%
630	4600	540	99.46%
800	6000	585	99.48%
1000	7500	640	99.50%
1250	8800	790	99.52%
1600	10800	975	99.54%
2000	13000	1130	99.56%
2500	15500	1320	99.58%
3150	19000	1630	99.59%

TABLE 3: MEPS LEVEL 3 FOR 3-PHASE LIQUID IMMERSER TRANSFORMERS

(b) Single-phase liquid-immersed distribution transformers

i. MEPS Level 1

This is to be effective within one year of this standard being gazetted as the Botswana Minimum Energy Performance Standard for Distribution Transformers.

Rated Power, IEC 60076-1	Maximum Load Losses	Maximum No-Load Losses	Percent Efficiency at 50% load
(kVA)	(watts)	(watts)	(%)
5	133	37	97.17%
10	243	44	97.90%
15	331	58	98.13%
25	486	83	98.36%
50	889	119	98.63%
100	1535	211	98.81%

TABLE 4: MEPS LEVEL 1 FOR SINGLE PHASE LIQUID IMMERSER TRANSFORMERS

ii. MEPS Level 2

This is to be effective within four years of this standard being gazetted as the Botswana Minimum Energy Performance Standard for Distribution Transformers.

Rated Power, IEC 60076-1	Maximum Load Losses	Maximum No-Load Losses	Percent Efficiency at 50% load
(kVA)	(watts)	(watts)	(%)
5	123	28	97.68%
10	224	33	98.23%
15	305	43	98.42%
25	448	61	98.61%
50	819	88	98.83%
100	1414	155	98.98%

TABLE 5: MEPS LEVEL 2 FOR SINGLE PHASE LIQUID IMMERSER TRANSFORMERS

iii. MEPS Level 3

This is to be effective within seven years of this standard being gazetted as the Botswana Minimum Energy Performance Standard for Distribution Transformers.

Rated Power, IEC 60076-1	Maximum Load Losses	Maximum No-Load Losses	Percent Efficiency at 50% load
(kVA)	(watts)	(watts)	(%)
5	112	18	98.18%
10	205	21	98.56%
15	278	27	98.71%
25	410	39	98.87%
50	749	56	99.03%
100	1293	99	99.16%

TABLE 6: MEPS LEVEL 3 FOR SINGLE PHASE LIQUID IMMERSSED TRANSFORMERS

The losses given in Table 1 and 3 above can be weighted by the correction factors given in **Table 7 below**, to take account of variations related to the highest voltage for equipment values.

The level of losses given in Table 1 to 3 above shall be weighted by the correction factors given in **Table 8 below**, to take account of variations related to dual voltage windings.

For power transformers having dual voltage on both windings for which both voltages on one winding are fully rated in combination with one of the voltages on the other winding, the levels of losses shall be based on the highest power and the values indicated in Table 1 and 2 above can be increased by 15 % for no load losses and by 10 % for load losses. The level of losses shall refer to the **highest voltages of both windings**. This remains valid even if further voltage combinations are available.

For a power transformer having an **insulation level according to Table 7 below** and having **dual voltage according to Table 8 below** the **loss level shall take into account BOTH corrections**.

TABLE 7: CORRECTION OF LOAD LOSS AND NO-LOAD LOSS APPLICABLE TO OTHER INSULATION LEVELS

Ref	Highest voltage for equipment values	Correction of load loss and no-load loss
1	One winding with $1,1 \text{ kV} < U_m \leq 24 \text{ kV}$ and the other with $1,1 \text{ kV} < U_m \leq 24 \text{ kV}$	The maximum losses indicated in Table 1 and 2 can be increased by 10 % for no load loss and by 10 % for load loss.
2	One winding with $24 \text{ kV} < U_m \leq 36 \text{ kV}$ and the other with $U_m \leq 1,1 \text{ kV}$	The maximum losses indicated in Table 1 and 2 can be increased by 15 % for no load loss and by 10 % for load loss and short circuit impedance unless otherwise specified should be increased by adding a value of 0,5 %.
3	One winding with $24 \text{ kV} < U_m \leq 36 \text{ kV}$ and the other with $U_m > 1,1 \text{ kV}$	The maximum levels of losses indicated in Table 1 and 2 can be increased by 20 % for no load loss and by 15 % for load loss and short circuit impedance unless otherwise specified should be increased by adding a value of 0,5 %.

TABLE 8: CORRECTION OF LOAD LOSS AND NO-LOAD LOSS APPLICABLE TO DUAL VOLTAGE

Ref	Dual voltage	Correction of load loss and no-load loss
A	One winding	<p>In the case of power transformers with one high-voltage winding and two voltages available from tapped low-voltage winding, losses shall be calculated based on the higher low-voltage and shall comply with the levels indicated in Table 1 and 2.</p> <p>The maximum available power on the lower low voltage on such power transformers shall be no more than 0,85 times its rated power.</p> <p>In the case of power transformers with one high-voltage winding with two voltages available from a tap, the maximum available power on the lower high-voltage on such power transformer shall be limited to 0,85 of its nominal rated power.</p> <p>In the case where the full rated power is available regardless of the combination of voltages, the levels of losses indicated in Table 1 and 2 can be increased by 15 % for no load loss and by 10 % for load loss. Such levels of losses shall refer to the highest voltage.</p>
B	Both windings	<p>The maximum allowable losses indicated in Table 1 and 2 can be increased by 20 % for no load losses and by 20 % for load losses for power transformers with dual voltage on both windings if the rated power is the same regardless of the combination of voltages. The level of losses shall refer to the highest voltages of both windings. This remains valid even if further voltage combinations are available.</p>

2.2.2.2. PCB Contamination Requirements

Transformers within the scope of this regulation shall comply with the Stockholm Convention on Persistent Organic Pollutants and shall not contain PCB (Polychlorinatedbiphenyls) fluids or other hazardous materials as defined in the relevant international, regional and national regulations that Botswana has adopted.

2.3. MEPS Implementation Plan

To support the proposed adoption of the proposed national standards and MEPS, the following actions and measures are recommended:

TABLE 9: MEPS ACTION PLAN

ACTION	AGENCY INVOLVED	TIMELINE
<p>Introduction of Botswana DT standards and MEPS: The Technical Committee endorsed the proposed standards and MEPS and agreed to introduce them as voluntary standards. The outstanding action here is the presentation of the Final Draft Standards to the Board of BOBS for their approval and publishing of the MEPS as a Final Standard.</p>	Botswana Bureau of Standards	3 months. The Board approval meeting is planned for November 2022 and the publishing of the final standard is scheduled for Q1 2023.
<p>Adoption of MEPS Tier 1: As the main procurer of transformers, BPC should adopt the Tier 1 MEPS into their procurement criteria for all newly purchased distribution transformers from 2024. The Department of Energy would offer support in including the Higher Efficiency DTs within their priority equipment to receive government support to achieve energy and environmental goals.</p>	Department of Energy, Botswana Power Corporation	Q1 2024

Adoption of MEPS Tier 2: As the main procurer of transformers, BPC should upgrade and adopt the Tier 2 MEPS into their procurement criteria for all newly purchased distribution transformers from the year 2027.	Department of Energy, Botswana Power Corporation	Q1 2027
Adoption of MEPS Tier 3: As the main procurer of transformers, BPC should upgrade and adopt the Tier 3 MEPS into their procurement criteria for all newly purchased distribution transformers from 2030.	Department of Energy, Botswana Power Corporation	Q1 2030

The phased adoption of the DT MEPS by BPC has been proposed deliberately to ensure that the capital cost of the distribution transformers does not change significantly with the MEPS specifications. Through bulk procurement practice, manufacturers can meet the MEPS requirements for a large order thus allowing Botswana to benefit from economies of scale. The annual procurement budget for the utility is expected to finance the cost of procuring the higher efficiency DTs with the expected revenues gained by reducing on distribution losses allowing them to meet the price difference.

3. DT Labelling and Consumer Awareness

3.1. Overview of Labelling

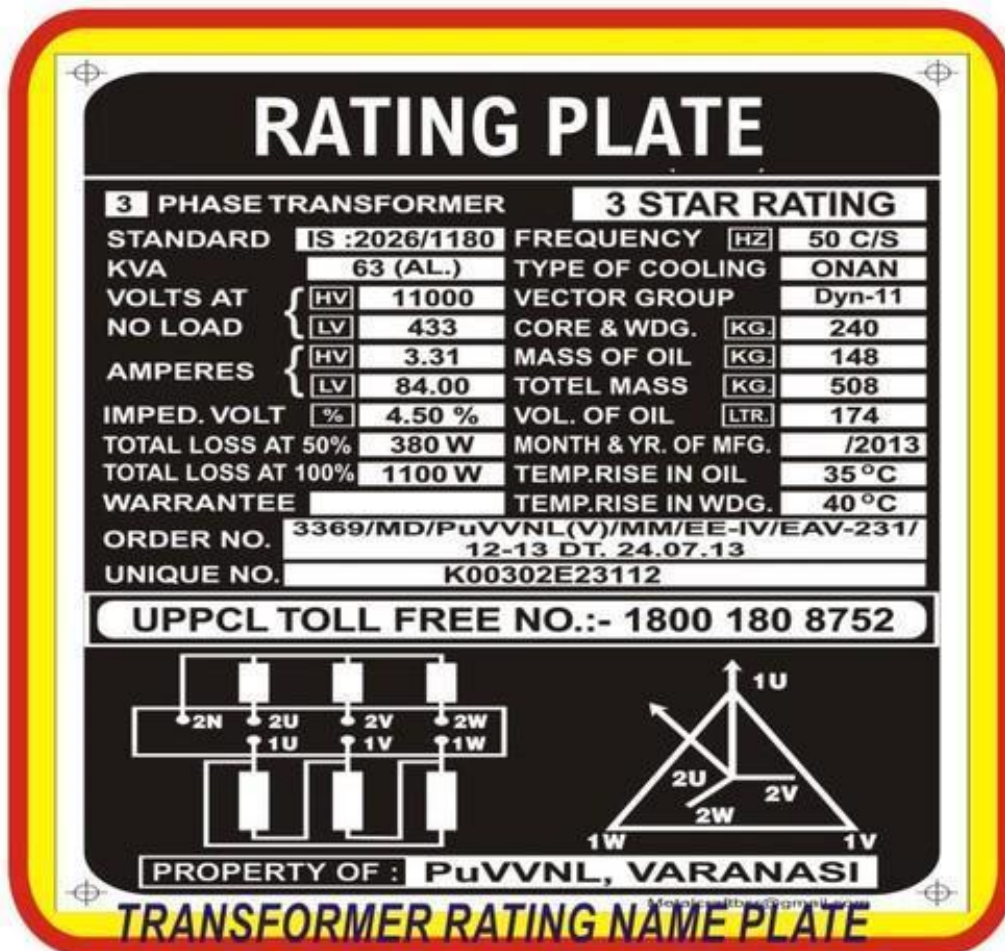
Product labelling is designed to inform end-users of the energy consumption levels of allowed products. It is often employed as an instrument to empower consumers of household appliances such as refrigerators, lighting and air conditioners. Unlike consumer goods, distribution transformers are often procured and used by a small pool of highly technical users such as utilities or mining companies. For niche equipment such as distribution transformers, labels are not typically used due to the conditions under which distribution transformers operate.

DTs are static devices that are usually ground or pole-mounted and exposed to extreme natural weather elements as well as dust and oil. For this reason, the exterior architecture of a transformer is usually robust and water and oil proof with ventilating fins for air circulation. This construction does not lend itself to labelling as the label requires a smooth clean surface to be affixed and for it to remain visible and legible over a long duration.

However, during stakeholder engagement and in making considerations for regional harmonization to ease trade, it was agreed that it may be useful to design a temporary label for Distribution Transformers to complement the MEPS. The proposal is presented in Section 3.2 below.

3.2. Recommendation for Distribution Transformer Labelling in Botswana

As highlighted in Chapter 2, the primary user and procurer of distribution transformers in Botswana is the Botswana Power Corporation. BPC employees are highly technical and have a good understanding of the metallic nameplate that is normally bolted onto a distribution transformer. An example transformer nameplate is illustrated below.



Within the scope of the MEPS regulation, the following product information requirements for power transformers are included to govern any accompanying related product documentation such as manuals and free access websites of manufacturers:

- a) information on rated power
- b) load loss and no-load loss
- c) the electrical power of any cooling system required
- d) information on the weight of all the main components of a power transformer (including at least the conductor, the nature of the conductor and the core material)
- e) manufacturer/repairer name
- f) year of manufacturing/repairing
- g) serial number


The above-mentioned information shall be durably marked on or near the rating plate of the power transformer. This information is important in guiding the utility on the suitability of a particular transformer for a specific network.

In supporting the adoption of MEPS, customs officials from BURS are envisioned to be conducting the preliminary checks at the borders once equipment such as transformers are imported, to ensure compliance before they are granted entry into Botswana. To ease the work of these compliance officers from BURS or BOBS who are typically found at the point of entry, we recommend the inclusion of a label together with the nameplate. The main use of the label would be to assist non-technical staff during border control to identify and verify that the transformers being imported are compliant with the MEPS. The label would be easier to understand than a nameplate and even if it fades or even falls off later during operation, it will have served its **purpose during conformity assessment at the point of import.**

The label shall be affixed on the product in a location that is **readily visible** for the customs officials such as on the smooth sides of the transformer. Any transformer labelled D would be immediately barred from entry into Botswana for being non-compliant. As government procurement is envisioned, it is assumed that the supplier would have won a tender to supply a given number of units under a government contract and that should be captured in the label to flag the specific use of a particular consignment of distribution transformers.


The labels would follow the same Tier 1, Tier 2 and Tier 3 requirements specified in the MEPS. A proposed design is provided below.

Transformer Efficiency Level

	<ul style="list-style-type: none"> • A - Tier 3 • B - Tier 2 Valid until 31 Dec 2030 • C - Tier 1 Valid until 31 Dec 2027 • D - Non-Compliant
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Date of Contract Award :	Contract Number :
Date of Order Placement :	Order Number :
Manufacturer :	Year of Manufacture :
Transformer Serial Number :	
Capacity (kVA) :	Secondary Voltage:
Primary Voltage :	
Load Losses :	No Load Losses :

Note: transformers that comply to Tier 3 efficiencies consume less power than their Tier 2 and Tier 1 alternatives.



Tier 3 transformers provide a financial benefit to the customer over its lifetime in operation and is better for the environment.

The label should indicate:

- 1) Date of contract award and contract number
- 2) Date of order placement and order number
- 3) Manufacturer and the year of manufacture
- 4) Transformer serial number
- 5) Capacity in kVA
- 6) Primary and secondary voltage
- 7) Load and no-load losses

3.2.1. Consumer Awareness for Distribution Transformers in Botswana.

As distribution transformers are generally procured by specialized companies such as the utility, BPC , the consumer awareness and education is directly targeted towards them. During the development of the roadmap, training on the Total Cost of Ownership was delivered to BPC officials who participate in the specification and procurement of transformers. This was to empower them to properly quantify revenue savings from higher efficiency distribution transformers to justify the cost of specifying higher efficiencies during the preparation of their tender documentation in future. Transformers are often procured on a need basis thus there is no predefined time when the next tender documentation will be prepared but the procurement officers were trained in advance to prepare them to immediately apply the MEPS in their next procurement cycle.

Regarding the proposed labels, the specific customs officials from BURS that would be engaged in the inspection would require more detailed training conducted by BOBS and BPC to explain the levels on the label and their significance. Primarily the messaging would be that **after 2023, any distribution transformers that is labelled D is non-compliant** and should not be issued with a Certificate of Conformity.

3.3. DT Labelling Implementation Plan

The introduction of a DT label is proposed as an additional supporting measure for enforcing the MEPS. It is worth noting that the function of the label in this case is more for compliance and not comparison. Therefore, the primary consumer of the labels is Customs Officers and that significantly influences the actions to be taken as it's a targeted intervention.

TABLE 10: LABELLING ACTION PLAN

ACTION	AGENCY INVOLVED	TIMELINE
Final design of DT label: As transformers are exclusively used by the utility, the regulator would be in charge of the final design and nationalization of the proposed label.	Botswana Energy Regulatory Authority	1 year: To align with the 2024 timeline for the Tier 1 MEPS.
Printing of the label: Once the Botswana DT label design is completed, the cost of printing and affixing the label will be passed on to the manufacturers as the labels would require to be attached before shipping. This cost would be negligible as a fraction of the actual cost of the transformer and as it will be included as a specification by BPC during procurement, it will be required before the issuance of a Certificate of Conformity.	Botswana Power Corporation, Manufacturers	Q1 2024
Training of BURS customs officials on the use of the DT label to check for compliance: This would be to ensure alignment on the need to have only MEPS compliant DTs being procured and supplied.	Botswana Power Corporation, Botswana Bureau of Standards	Q1 2023
Rescaling the label after 2030 to upgrade the information on the label: As technology evolves and higher efficiency options become available at an affordable cost, the label will require to reflect the new options.	Botswana Energy Regulatory Authority	2030

4. Monitoring, Verification & Enforcement Framework for Distribution Transformers

4.1. Overview of MV&E Framework

Strategic compliance programmes are critical to safeguarding energy savings, CO₂ emissions reductions, and other benefits accrued from introducing MEPS and labels. A holistic compliance framework enhances the credibility of government energy efficiency programmes, protects consumers, and creates a fair playing field for suppliers of energy-efficient and quality equipment. The overall objective of the proposed MV&E framework is to safeguard energy savings expected from the transition to higher of Botswana's energy efficiency initiatives by ensuring that the newly procured distribution transformers meet the specified minimum efficiency standards.

The following are the expected results

- Increased stakeholder support for energy efficiency programmes – the aim is to raise awareness among the key users of distribution transformers on the long term positive economic and environmental impact of moving to higher efficiencies.
- Improved compliance rates among suppliers of DTs
- Overall increase in the country's energy savings
- MV&E information and knowledge used for learning, continuous improvement and evidence-based decision making and policy formulation
- Protecting the domestic market from imports of DTs with poor energy performance
- Strengthened MEPS accountability system

4.2. Recommendations for the MV&E Framework for DTs

For DTs, test facilities can be expensive to set up for purposes of compliance testing. Since Botswana imports all their distribution transformers, this roadmap does not recommend the setting up of a testing facility in country. In the absence of accredited testing facilities within the country options for low-cost, high-quality training include:

- Pooling resources with neighboring countries to establish a regionally funded and managed test laboratory.
- Relying on existing test facilities from the country of origin since most distribution transformers are imported. BPC and BERA staff would participate in Factory Acceptance Testing inspections before issuing Certificates of Compliance to DTs that meet the standards.

During the preparation of this roadmap, key agencies were identified to play critical roles in the MV&E implementation. The agencies, their capacities and proposed roles are presented below.

4.2.1. Agencies Involved

Systematic monitoring of all ports of entry into the country helps to control legal imports and prevent illegal imports of non-compliant distribution transformers through mislabeling or false documentation. Some of the agencies involved in customs clearance include:

4.2.1.1. Botswana Unified Revenue Service (BURS)

One of the key agencies involved in customs procedures is the Botswana Unified Revenue Service (BURS). This is the main revenue service agency of the Botswana government and is responsible for tax collection and administration of the BURS Act. As enforcement officers at the borders and all points of entry for cargo, customs officials are responsible for examining respective documents and cargo. The initial examination is for identification of shipments of appliances and to distinguish between imports of qualified products and disqualified products.

The roles that the customs department should play in effecting the MV&E scheme include:

- Verification of paperwork: Import papers should be verified for accuracy and compliance.
- Check for mislabeling. Trained officers should physically inspect and analyze the distribution transformers if the shipment papers are suspect or incomplete information is provided. This could be done with the help of technical experts from BPC.
- Examination and seizure of disqualified products found to be noncompliant with the Botswana DT MEPS

Importers are responsible for checking if they are subject to any prohibitions or restrictions for any goods imported into Botswana. The Customs Officials are required to ensure compliance with customs law and other related legislation. Once the MEPS and labelling regulations are adopted, they will form part of the import legislation requiring importers to comply with specific labeling and energy performance requirements of targeted appliances.

4.2.1.2. Botswana Bureau of Standards (BOBS)

The Botswana Bureau of Standards (BOBS) is mandated with formulating standards and coordinating quality assurance activities in Botswana. The Botswana Bureau of Standards (BOBS) implemented the Botswana (Import Inspections Regulations) SIIR to assure Botswana consumers of the quality and safety of imported goods and also to facilitate trade.

'Regulated Products' exported to Botswana that are within the program require a Certificate of Compliance which verifies, in the respective exporting countries, that the products comply with the applicable Botswana technical regulations and mandatory standards or approved equivalent International/National Standards.

BOBS has led the development of the test standard and MEPS through chairing the Technical Committee that was involved in endorsing and publishing the standard. Due to their years of experience in market surveillance and compliance through Pre-shipment Verification of Conformity (PVoC), BOBS has been nominated to support the early stages of adoption of MEPS as BERA which is a much younger institution builds their internal capacity to take over the market surveillance.

4.2.1.3. Ministry of Minerals and Energy

The MME is the lead policy-making authority of Government of Botswana on all matters pertaining to mining and energy. It coordinates development and operational activities for the whole energy sector. The Department of Energy (DOE) is the lead policy-making authority of Government on all energy supply and demand matters. The Department of Energy (DOE) is broadly responsible for the following functions.

- To lead policy-making authority of Government on all matters of energy supply and demand management.
- To formulate and coordinate national energy policy and programmes.
- To facilitate the availability of effective, reliable and affordable energy services to customers in an environmentally sustainable manner

The primary role of the DOE in implementing the MV&E scheme for distribution transformers would be to work with other government agencies to find the resources for the implementation of the project. These activities would include:

- Coordinating with the Ministry of Finance to include the Energy Efficiency project for distribution transformers in the GCF Country Programming as one of the Ministry's priorities.
- Prepare the official documentation to include the Energy Efficiency project for DTs into the National Development Plan 12 for the project to be aligned with the NDP 12 goals and shortlisted as a funding priority for the government.
- Working closely with the Ministry of Finance to include the project in the budget planning exercise for the next financial year.

4.2.1.4. Botswana Energy Regulatory Authority (BERA)

BERA is mandated to handle all regulatory issues of the entire energy sector. BERA currently regulates the technical and economic aspects of the electricity sector, administers licenses for sector activities and makes recommendations to the Minister of MMGE regarding issuance of licenses. Once they build their capacity, BERA would be the leading agency in verifying and approving DT laboratory test reports for compliance. They would also take the lead in labelling scheme design and the implementation.

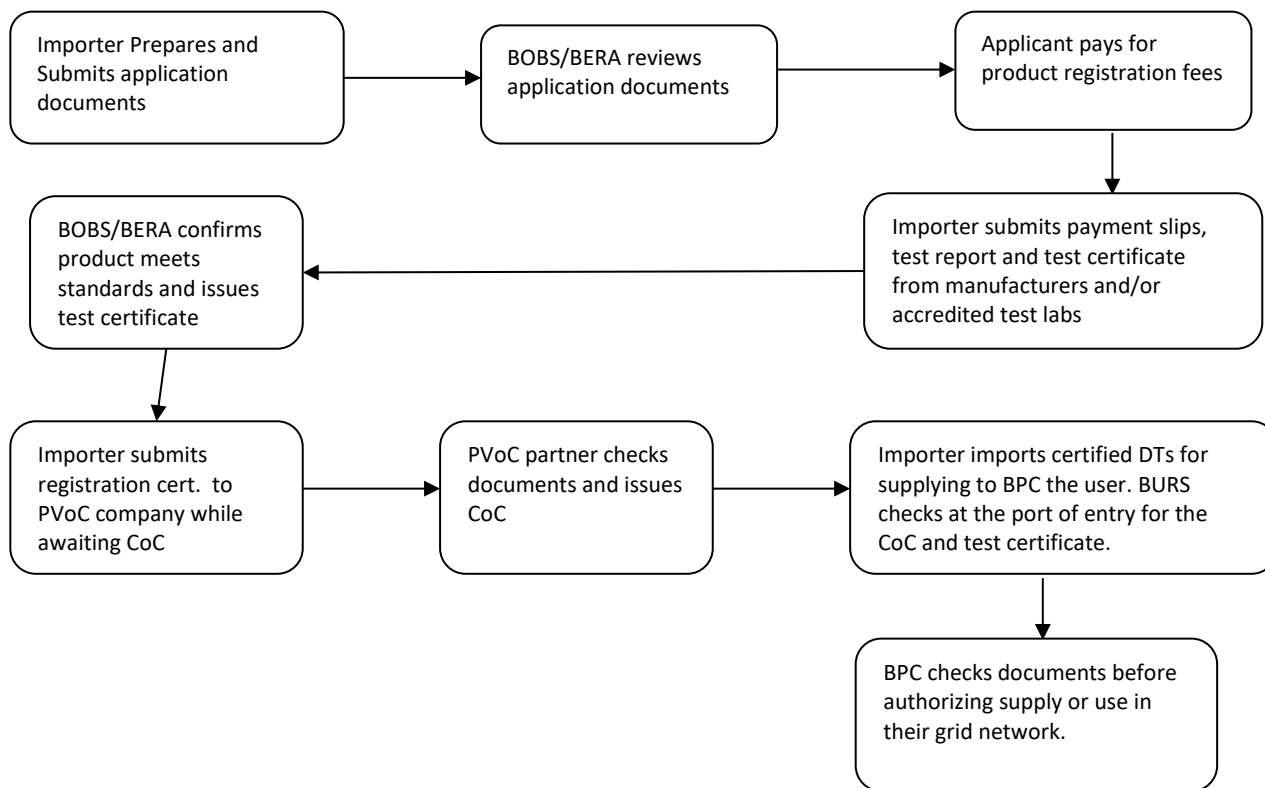
The key roles for BERA as envisaged under the MV&E Framework include,

- Maintain accreditation for DT suppliers as per the MEPS requirements
- Certify DT performance according to Botswana's MEPS.
- Procuring DT models selected for verification testing
- Maintaining DT test report templates that are developed by BPC
- Approving manufacturer laboratory test reports for conformity assessment purposes.

When a distribution transformer does not comply with the set MEPS regulations, BERA can propose further corrective actions that may include seizure, market withdrawal, penalties or return to country of origin.

4.2.2. Proposed MV&E Framework for Distribution Transformers

Since transformers are mostly procured and used by BPC, the key agencies identified to support the process are BOBS, BERA and BPC. In the initial stages, **BOBS will lead the verification in the initial phases, however once BERA builds their capacity in compliance checking, they will take over the process** because it is more efficient for co-ordination as both BOBS and BPC are agencies under the Ministry of Minerals and Energy. Below is the proposed compliance framework for DTs in Botswana.



4.3. MV&E Implementation Plan

Botswana is a country with a small population and a central grid network. The enforcement to improve the efficiency performance of DTs is hinged on the smooth co-ordination between government agencies to make the process of testing, certification, and importation clear for suppliers of BPC as the primary consumer of DTs. Unlike consumer goods, distribution transformer quality can almost entirely be controlled by tightening the entry requirements. Market surveillance is a much less useful tool than in the case of household appliances. The proposal below, discussed with the key agencies involved focuses mostly on the documentation required for import compliance.

TABLE 11: MV&E ACTION PLAN

ACTION	AGENCY INVOLVED	TIMELINE
Publish framework to delineate responsibilities between agencies: The proposal above should be included as one of the regulations under BERA to strengthen the authority of compliance officers. The DoE would co-ordinate the meetings between BPC and BERA to assign responsibilities for DT verification.	Botswana Energy Regulatory Authority, Botswana Power Corporation, Department of Energy	Q2 2023
Publish test procedures for DTs and make them available to all stakeholders: The test standard developed and endorsed by BOBS completed public consultation in August. The remaining step is to have the Final Standard approved by the Board and published for use.	Botswana Bureau of Standards	Q1 2023
Map testing facilities: BPC and BOBS will need to aid manufacturers and importers to identify accredited labs that can issue them with quality test reports. As BPC is the main procurer of DTs, they are more aware of which metrics are important for	Botswana Power Corporation, Botswana Bureau of Standards	Q3 2023

performance testing and BOBS already has relationships with external labs to support the PVoC process.		
Publish the certification requirements: BERA and BPC should develop clear guideline documents for how manufacturers can certify compliant DTs and share with them a certificate template. The requirements should detail general requirements such as what would be the sample size for a consignment of DTs to be considered to have met compliance requirements. Lastly, the procurement specifications by BPC should include a requirement for their suppliers to include a signed compliance statement acknowledging responsibility for supplying MEPS compliant DTs.	Botswana Energy Regulatory Authority, Botswana Power Corporation	Q3 2023
Expand existing PVoC programme to include energy performance checks for DTs: BPC conducts factory acceptance checks before transformers are imported into Botswana. The new procurement specification that includes MEPS will require that the test reports also include the energy performance of the DTs. This new test report formats should be shared with the PVoC companies that BOBS uses, so that they are aware that for DTs beyond safety and quality checks, they must also check for performance before issuing the Certificate of Conformity prior to the DT being shipped.	Botswana Bureau of Standards, Botswana Power Corporation	Q1 2024
Develop and maintain a Product Registration System: BERA and BOBS should develop a PRS system to provide a central information repository. Information provided by importers during the registration of DTs should be captured in the PRS. This allows for identical DT models that have already been previously tested to be prequalified without incurring the cost of further testing. Additionally, it provides an opportunity to collect registration fees which could help finance the co-ordination of the compliance framework.	Botswana Energy Regulatory Authority, Botswana Bureau of Standards	Q1 2024

5. Proposed Financing Mechanisms for Distribution Transformers

5.1. Overview of Financing Mechanisms

This proposal reviewed financing mechanisms for energy efficient distribution transformers with the objective of informing the Government of Botswana of the options available to them to catalyze adoption of MEPS for distribution transformers. If implemented effectively, the financing mechanisms should support the Botswana Power Corporation to procure higher efficiency distribution transformers. The proposal was informed by

- desk research
- the capacity building session held in Botswana with sector stakeholders in June 2022 and the public stakeholder consultation held in August 2022
- discussions held with the Ministry of Finance, The Department of Energy, Botswana Unified Revenue Services and officials of the Botswana Power Corporation.

5.1.1. Financing Mechanisms Suitable for Distribution Transformers

Some of the financing mechanisms that are frequently employed to purchase distribution transformers globally are:

5.1.1.1. Utility Regulatory Frameworks

Additional generation is required to compensate for losses in the transmission and distribution system, which costs money and puts a burden on already restricted generating assets. Progressive regulatory regimes seek to strike an ideal economic balance between protecting end-user customers' interests and ensuring that the utility benefits from energy efficiency improvements in its own network. If network operators are sufficiently rewarded, they will weigh the costs and benefits of decreasing losses and take steps to reduce losses as efficiently as possible, including purchasing energy-efficient transformers.

5.1.1.2. Guarantees

Guarantee instruments are meant to mitigate some of the risks associated with loan repayment. They seek to lower financing institutions' perceived risks in the short term while also increasing their technical and financial trust in certain energy efficiency programs over time. This reduces the interest repayment costs for the utility.

5.1.1.3. Public Private Partnerships

Public-Private Partnerships (PPPs) are mechanisms that allow governments to fund and operate services through private-sector contracts. PPPs are typically deployed in financing generating assets but they could also be extended to distribution assets such as transformers.

5.1.1.4. Energy Savings Performance Contracting through ESCOs

An ESCO is a company that offers a wide range of turnkey energy solutions, including upgrades to electrical systems in commercial and industrial buildings as part of a larger energy efficiency plan. ESCOs adopt the guaranteed savings model where they guarantee the energy savings (by taking on the technical risk) for any efficiency improvements made.

5.1.1.5. Revolving Loan Funds

Revolving fund is any reimbursable investment instrument in which the repayments and/or proceeds of initial investments are re-invested in additional qualifying projects

5.1.1.6. Bulk Procurement

The buying of multiple units of an appliance from a manufacturer allows the customer to negotiate better prices due to economies of scale. Finally, the procurement of efficient transformers could also be financed through carbon credits or government **loan guarantee schemes**¹.

5.2. Recommended Financing Mechanisms for Distribution Transformers in Botswana

The Botswana transformer market is estimated to be 1,400 units annually as of 2020 based on import data. A review of the [National Development Plan 11](#) for Botswana shows that development expenditure of over P100 billion (**7.5Bn USD**) is planned for the period 2017/18 – 2023/24; the bulk of which is to fund infrastructure projects in areas such as energy with priority being given to the upgrade and maintenance of existing infrastructure. Moreover, as financing incentives are short-term solutions, they must be strongly linked with and complemented by long-term policies and regulations.

5.2.1. Public Private Partnerships

To deliver capital investments whilst maintaining sound fiscal policies, there is need to look for support and collaboration from other sectors of the economy. Public-private partnership (PPP) is one of the forms of such collaboration between government and the private sector. It is based on the recognition that both the public and private sectors can benefit by pooling their financial resources, know-how and expertise to improve the delivery of basic services to all citizens. Government of Botswana is promoting the use of PPPs in developing and operating public infrastructure and related facilities. The following initiatives confirm Government's commitment to the involvement of the private sector in financing and managing infrastructure projects:

- a. Adoption of the Privatization Policy aimed at providing an optimal balance between the public and private sectors to achieve sustainable economic growth
- b. Adoption of the PPP Policy and Implementation Framework to create a conducive environment to encourage and attract private sector investors to play a greater role in procuring and financing of infrastructure projects
- c. Establishment of the PPP Unit within the Ministry of Finance and Economic Development to ensure successful implementation of the PPP Policy

The Department of Energy can leverage the existing PPP policy framework to attract suppliers of distribution transformers to BPC to partner with the government for long term contracts at preferential rates. This would help the affordability of the higher distribution transformers by the utility as the capital cost would be borne by the private sector and the revenues from running an efficiency utility would be used to pay back the suppliers.

5.2.2. Utility Regulatory Frameworks

The Republic of Botswana received financing from the African Development Bank (AfDB), through the Sustainable Energy Fund for Africa (SEFA), toward "Botswana Renewable Energy Support Project". The financing was for the operationalization of policy and regulatory framework for Integrated Resource Plan (IRP), implementation and development of regulatory instruments and technical studies. All these initiatives are geared towards providing consumers with affordable and reliable electricity. The financing from AfDB and other similar concepts are designed to reward system efficiency and effectiveness which can be achieved in partnership with professional organizations and energy experts who undertake consultancy and advisory work partnering with BPC and BERA who would then execute the recommendations.

¹ *The National Development Bank in Botswana has a loan facility that caters to Energy Projects for farmers, particularly Renewable Energy Technologies. NDB and other Banks will likely have an interest in the subject since they understand the cash flows from efficiency.*

Botswana is seeking to strike an ideal economic balance between ensuring electricity remains affordable while supporting the utility to maximize on energy efficiency and loss reduction improvements in its own network. Using the Total Cost of Ownership approach, BPC officials who have now been trained can provide the evidence that compares the costs and benefits of decreasing operating losses using higher efficiency transformers. This evidence is necessary to support Board decisions as well as regulatory support from BERA to attract investment to procure higher efficiency DTs.

5.2.3. Guarantees

Guarantees seek to lower financing institutions' perceived risks in the short term while also increasing their technical and financial trust in certain energy efficiency programs over time. The African Development Fund Partial Credit Guarantee (ADF-PCG) is an instrument designed to address the challenges faced by ADF countries like Botswana and State-Owned Enterprises like BPC in their quest to mobilize both domestic and external commercial financing for developmental purposes. The ADF PCG guarantees the debt service obligations of ADF countries, at low or moderate risk of debt distress and who have adequate debt management capacity. The ADF PCG also requires a counter indemnity from the beneficiary Regional Member Country in which the country agrees to reimburse the fund for any amounts paid under the guarantee. Based on our engagement in Botswana, we observed that the country has a politically stable environment, underpinned by prudent economic management and strong institutions. As a result of rigorous economic management and strong political institutions, the country has managed to transform itself from one of the poorest countries at independence into an upper middle-income country, characterized by good governance and macroeconomic management. Botswana is widely reputed for its transparency, openness and overall good governance and therefore eligible for such guarantees to transition to energy efficient DTs through the Ministry of Energy (BPC) and Africa Development Fund. BPC could leverage this facility to access loans at concessionary rates for meeting the capital cost of procuring and installing higher efficiency transformers².

5.2.4. Revolving Loan Funds

A revolving fund is any reimbursable investment instrument in which the repayments and/or proceeds of initial investments are re-invested in additional qualifying projects (Carbon Trust, 2018). The main advantage of public sector revolving loan funds is that they often have lower interest rates and longer-term tenors than commercial bank loans. In some circumstances, repayments can be matched with electricity bill savings resulting from increased efficiency.

Some examples of such funds that Botswana could tap into include SUNREF. The objective of the SUNREF initiative developed by Agence Française de Développement (AFD) is to support financial institutions and their clients to boost financing for projects for sustainable natural resources management, with a focus on clean energy. SUNREF provides an affordable line of credit together with project development technical assistance to help develop energy investments and credit facilities to provide banks with the necessary long-term financing to overcome financial barriers met by project sponsors. This would be recommended for Botswana as the concessional loans under this programme are characterized by low interest rates, long tenor, and a long grace period. Another recommended revolving fund partner is SEFA who has spearheaded the African Development Bank's engagement in green mini grids.

Commercial banks available in Botswana who could be sensitized about revolving funds include:

- a. Access Bank Botswana Limited (formerly BancABC)
- b. Bank Gaborone Limited
- c. Bank of Baroda (Botswana) Limited
- d. ABSA Bank Botswana Limited
- e. First Capital Bank Limited

² Botswana, through the Ministry of Environment, Natural Resources Conservation and Tourism (MENT) is developing green building protocols with financial assistance from the United Nations Development Programme (UNDP) to support green certification on water and energy efficiency. A similar concept for distribution transformers should be considered.

- f. First National Bank of Botswana Limited
- g. Stanbic Bank Botswana Limited
- h. Standard Chartered Bank Botswana Limited

These funds could support suppliers of higher efficiency transformers to BPC access credit from commercial banks at preferential rates.

5.2.5. Bulk Procurement

As the largest consumer of distribution transformers in Botswana, bulk procurement will enable BPC to make the best use of scarce capital resources. Most importantly, the bulk procurement will support the implementation of efficiency standards, and help create sustainability, passing on resulting savings to end-users. The potential for efficient DTs cost reduction through bulk procurement in Botswana depends on the volume which is well justified in the growing forecast and capacity at BPC as demonstrated by the strong balance sheet of 10,540,176 Pula net assets and total assets at 23,376,505 Pula.

5.3. Financing Mechanism Implementation Plan

The actions proposed focus on options that are available to BPC and other government agencies to raise the investment capital necessary to support the initial increased expense of transitioning to higher efficiency DTs. These are temporary measures as the sustainability of the program is dependent on the volumes being high enough to allow the utility to benefit from favorable prices due to economies of scale. Additionally, as more countries transition towards higher efficiency DTs, the market push would lead to a lowering of the overall purchase price of the equipment which is a saving that will also be passed on to the Botswana consumer.

TABLE 12: FINANCING ACTION PLAN

ACTION	AGENCY INVOLVED	TIMELINE
Prepare bulk procurement tenders that include the MEPS as part of the specification requirements: BPC purchases around 1,400 transformers annually. With the introduction of the MEPS and the training of BPC officials on the TCO model for lifetime cost assessment, the procurement team at BPC should make the cost-benefit analysis to understand how many transformers per batch could be procured so that the projected energy savings cover the initial capital cost difference. The volumes necessary to meet that break-even point would be ideal for a bulk purchase tender.	Botswana Power Corporation	Q1 2024
Inclusion of higher efficiency DTs as part of NDP 12 priorities to increase budget allocation to BPC: The next phase of planning for the NDP is currently ongoing until 2023. To support BPC in accessing resources for the adoption of higher efficiency DTs, The Ministry of Minerals and Energy could include the transition as a priority area in the NDP 12 narrative. Additionally, they could include BPC as a priority agency to receive an increased budgetary allocation from the Ministry of Finance during the next annual budget.	Department of Energy	Between Oct 2022 – June 2023
Research and apply for available guarantees and revolving funds that BPC is eligible for: BERA to form an internal advisory team that would conduct research on the available green funds and guarantees targeted towards environmental conservation. They should then serve as a knowledge hub for the DoE and BPC on application windows and requirements to maximize Botswana government access to external funds to subsidize energy efficiency initiatives.	Botswana Energy Regulatory Authority	From Q3 2023 onwards
Sensitizing commercial banks on revolving funds and preferential lending to suppliers of higher efficiency DTs: BERA and BPC should conduct outreach to the commercial banks in Botswana to inform them of the transition to higher efficiency DTs and engage on potential credit facilities customized for the suppliers of such equipment. Due to the large volumes required	Botswana Energy Regulatory Authority, Botswana Power Corporation	Q3 2023

<p>annually and the cost of an individual unit, this would be a valuable business proposal to the banks.</p>		
<p>Charging and collection of Product Registration Fees: The registration of compliant distribution transformers would ideally be done on a Product Registration System managed by BERA. The registration could be tied to a fee that a manufacturer or importer pays to have their model included once it acquires a Certificate of Compliance. This would also save them from getting an identical model retested later and serve as an information source for other suppliers interested in bidding for BPC tenders to know which models meet the Botswana MEPS requirements.</p>	<p>Botswana Energy Regulatory Authority</p>	<p>From 2024 onwards</p>

6. Summary Implementation Schedule and Budget

6.1. Summary Implementation Plan

The successful implementation of the various sub-components of the national roadmap plan for Distribution Transformers will be heavily influenced by the change in procurement procedures at Botswana Power Corporation and the building of internal compliance capacity at the Botswana Energy Regulatory Authority.

It is worth highlighting that the standards are being introduced in Botswana as voluntary standards due to the dominance of the BPC in use and procurement of DTs. It was discussed and understood by all agencies that the greatest avenue of change would be in the use of procurement specifications by BPC with MEPS included as part of the transformer specification criteria. The timelines provided allow for the introduction of compliance checks and other enforcement mechanisms to be feasible as the various agencies get familiar with the different requirements for monitoring and verification. It also provides time for the Product Registration Database to be created as well as BERA and BPC to develop the necessary testing and certification documentation to be used by various importers.

To guide the transition towards higher efficiency transformers, the presented sequence of events is proposed. The speed and scale at which the project can be fully adopted is dependent on the availability of the necessary funds to not only enhance the human resource of the various agencies involved but also create the necessary digital and physical infrastructure to support the proposed framework. The summary below illustrates a 2-year period of implementation to allow the relevant agencies in Botswana to initiate and complete the various actions proposed. This would equip the country with a stable and sustainable framework for the transition to higher efficiency DTs.

TABLE 13: IMPLEMENTATION TIMELINE

	Before adoption	Year 1				Year 2			
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Development of MEPS, labels, and MV&E procedures									
Capacity building on the benefits of MEPS for DTs for procurement officers at BPC									
Capacity building on label interpretation for BURS customs officials									
Publishing of the Botswana National Test Standard and DT MEPS									
Capacity building for compliance officers from BOBS, BERA and BURS on inspection of compliant DTs at the port of entry									
Recruitment of additional staff to support enforcement at BERA and BOBS									
Setting up of PVOC procedures/Product Registration Systems									
Design & Production of Labels to help with Compliance Checks at port of entry									
Stakeholder Consultations & Training on the MEPS and label for manufacturers and importers									
Communication & Awareness raising on the benefits of the higher efficiency DTs to commercial banks, mining companies and other relevant stakeholders									
Coming into force of the voluntary MEPS and test standard									

The plan is presented in quarterly time periods (3 months) where the various activities are scheduled. The plan envisions that the transition for distribution transformers will mostly occur in the procurement phases of the project. Thus, a lot of emphasis has been placed on the processes that must happen before a transformer is imported into Botswana.

These processes include but are not limited to:

- Proper detailed specification on minimum energy performance by BPC during the tendering process for procuring transformers

- Rigorous factory testing and other pre-shipment checks
- Pre-shipment conformity of assessment before the transformer is exported to Botswana
- Verification at the point of entry by the compliance officers that the test reports and certification meet the MEPS
- Registration of conforming products into the Product Registration System to have a central database that can be used as a reference point for transformer models that meet Botswana MEPS specifications

6.2. Estimated Budget to Implement Roadmap

The success of the proposed roadmap requires adequate resources and sustainable financing to achieve its objectives. To begin with, to raise the capital required for the acquisition of the higher efficiency transformers, the financing mechanisms available to Botswana would require an initial investment to facilitate the development of the necessary relationships and to institute the various approaches of capital raising such as PPPs, guarantees and revolving funds. Presented below is a budget estimate for the fundraising activities **estimated to cost 280,000USD.**

TABLE 14: FINANCING MECHANISM ACTIVITY BUDGET

Financing Mechanims	Activities	Units	Frequency	Unit Cost	Amount (USD)
PPP	Developing a PPP concept note	1	1	20,000.00	20,000.00
	Half day workshop with Potential Partners	50	1	50.00	2,500.00
	Benchmarking in other Jurisdictions	10	1	3,000.00	30,000.00
	Developing PPP Agreements	1	1	10,000.00	10,000.00
	Monitoring and follow up	1	1	5,000.00	5,000.00
Guarantees	Concept Note development	1	1	15,000.00	15,000.00
	Full day workshop on Guarantees with stakeholders	50	1	100.00	5,000.00
	Identification of potential guarantees based on the workshop	1	1	-	-
	Designing Guarantee agreements	1	1	10,000.00	10,000.00
	Monitoring and follow up	1	1	-	-
Revolving Fund	Assessment of potential Revolving funds (AFD and AfDB)	1	1	10,000.00	10,000.00
	Meetings with AFD and other potential funders	15	3	100.00	4,500.00
	Concept development	1	1	10,000.00	10,000.00
	Agreement with funder of the revolving fund	10	1	100.00	1,000.00
	Monitoring and follow up	1	1	5,000.00	5,000.00

Utility Regulatory Framework	Review of existing and potential utility regulatory frameworks	1	1	20,000.00	20,000.00
	Meetings to review the existing and potential regulatory frameworks	20	2	50.00	2,000.00
	Development of a matrix on applicable regulatory framework	1	1	-	-
	Adoption and implementation of the frameworks approved	1	1	-	-
	Monitoring and follow up	1	1	10,000.00	10,000.00
	Consultancy	2	100	600	120,000.00

Total Indicative Budget

280,000.00

The roadmap is a guide, but it envisions that the enforcement regime shall be flexible and adaptable to meet Botswana market needs as they arise. To further reduce the impact on the national budget, the Government of Botswana should leverage enforcement actions carried out by neighboring countries and within the region such as having a shared test lab facilities.

The following are the key cost components considered in the budget:³

- i. Establishment cost - These are activities such as setting up new offices and purchasing new equipment or software.
- ii. Staffing cost – This includes recruiting new staff, training and capacity building for the new and existing staff. There is need for a dedicated training for customs officers. This means that customs units operating at each border crossing will have adequately trained staff to conduct primary documentation checks and verify that transformer shipments meet the requirements.
- iii. Legal and enforcement action cost –A successful enforcement framework requires sufficient funding for the arising legal issues on non-compliance. It is also important to factor in non-compliance costs which may be applicable for removal and storage of non-compliant distribution transformers.
- iv. Awareness raising – The utility requires reliable information on which to base their purchasing decisions. In this regard, it is important to continually expand the training on the TCO model to new procurement recruits and other technical staff within BPC. Continuous training also enhances the understanding of MEPS.⁴

Table 15 below highlights the estimated costs for the proposed MVE Framework for Botswana.

³UNEP. (2016). *ENFORCING EFFICIENT LIGHTING REGULATIONS*. UNEP.

⁴IEA. (2010). *Monitoring, Verification and Enforcement: Improving compliance within equipment energy efficiency programmes*. Paris: IEA.

TABLE 15: DT NATIONAL ROADMAP BUDGET

	Activity	Cost (USD)	Timeline (Years)
1.	Additional staff for compliance at BERA and BOBS – 6 No.	100,000	1
2.	Capacity Building & Study Visit for BPC and BERA staff to a transformer manufacturer for testing and certification demonstrations as well as engaging with PVoC companies	40,000	1
3.	Setting up of Product Registration System by BERA to record compliant DT models	60,000	2
4.	Design and Production of Label samples by BERA for sending to manufacturers and importers of DTs for them to reproduce and affix to DTs before export.	10,000	1
5.	Stakeholder Awareness and training of BURS customs officials on compliance checks. This cost also includes outreach to commercial banks to extend credit lines to suppliers of transformers and any required inter-ministerial co-ordination meetings.	80,000	1
6.	Market Surveillance – This is a fund required by BERA to facilitate random checks with importers to ensure transformer consignments all meet the required standards and not just the sampled units alone.	75,000	3
7.	Legal and regulatory costs to facilitate the publishing of test standards and MEPs and the development of compliance guidelines and certification for compliant models.	50,000	1
8.	Cost of mobilizing financing for DTs – This is the preliminary cost to set up the Botswana energy sector environment for PPP, accessing guarantees and revolving funds.	280,000	
9.	Non-compliance Costs – This is a fund that will be required to support the mechanism for disposal or return of non-compliant DT models.	20,000	1
Total		715,000	

The above figures are estimates based on the expected operationalization costs for the proposed roadmap to higher efficiency distribution transformers in Botswana. With leveraging PVoC, it is possible to successfully implement the roadmap without putting up a testing facility. This would significantly reduce the implementation cost of the roadmap to **USD 715,000**.



REFERENCES – MV&E

- APEC. (2010). *APEC Cooperative Energy Efficiency Design for Sustainability (CEEDS)*. Tokyo: APEC.
- APEC. (2014). *APEC MV&E Network for Policymakers and Practitioners*. APEC.
- CLASP. (2010). *Compliance Counts: A Practitioner's Guidebook on Best Practice Monitoring, Verification, and Enforcement for Appliance Standards & Labeling*. CLASP.
- GOB. (2016). *National Development Plan II: 2017 - 2023*. Government of Botswana.
- GoB. (2018). *National Energy Efficiency Strategy for Botswana*. Government of Botswana.
- Government of British Colombia. (2007). *COMPLIANCE MANAGEMENT FRAMEWORK: The Ministry of Environment Approach to Ensuring Compliance*. Ministry of Environment, British Colombia.
- Government of Botswana. (2021). *National Energy Policy*. Government of Botswana.
- latridis, M., Tourkolias, C., Jamek, A., Pickl, N., Andersen, J., Kjaer, T., . . . Struss, B. (2016). *Synthesis report on European best practices for M&V schemes and coordination mechanisms*. European Union.
- ICF. (2015). *STANDARDS, RATING & LABELING ENERGY EFFICIENCY TOOLKIT – TECHNICAL GUIDE*. USAID.
- IEA. (2010). *Monitoring, Verification and Enforcement: Improving compliance within equipment energy efficiency programmes*. Paris: IEA.
- ITA. (2021, 10 10). *Botswana - Country Commercial Guide*. Retrieved from International Trade Administration: <https://www.trade.gov/country-commercial-guides/botswana-energy>
- Mathers, M. (2014). *STATUS REPORT ON LIGHTING MONITORING, VERIFICATION AND ENFORCEMENT ACTIVITIES AND PROGRAMMES IN CAMBODIA, INDONESIA, LAO PDR, THE PHILIPPINES, THAILAND AND VIET NAM*. UNEP.
- Mooiman, M., Molefhi, B., & Matlotse, E. (2016). *A Review of Energy Efficiency Initiatives in Botswana*.
- NERC. (2013). *North American Electric Reliability Corporation Compliance Monitoring and Enforcement Program*. NERC.
- PwC. (2016). *Development of standard and labelling (S&L) inspection guidelines for state designated agencies*. Shakti Foundation.
- SARDC. (2016). *RENEWABLE ENERGY & ENERGY EFFICIENCY STRATEGY & ACTION PLAN for the Southern African Development Community*. Harare : SARDC.
- SE4ALL. (2015). *Rapid Assessment Gap Analysis*. SE4ALL.
- UNEP. (2016). *ENFORCING EFFICIENT LIGHTING REGULATIONS*. UNEP.
- UNEP. (2020). *Development of Regional Product Database and Harmonization of National Product Registration Systems. A Regional Policy Roadmap*. UNEP.
- UNEP U4E. (2021). *ENSURING COMPLIANCE WITH MEPS AND ENERGY LABELS*. Paris: UNEP.
- Wiel, S., & McMahon, J. (2005). *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting* (2nd ed.). California, USA.
- World Bank. (2021, April 01). *The World Bank in Botswana*. Retrieved from The World Bank: <https://www.worldbank.org/en/country/botswana/overview#1>

REFERENCES – FINANCING MECHANISMS

- Abed, K. A., Badr, M. A., & Shouman, E. R. (2015). *Cost Analysis of Energy Efficient Domestic Refrigerators*. 4, 12.
- Adebola, S. S. (2011). *Electricity Consumption and Economic Growth: Trivariate investigation in Botswana with Capital Formation*. 1(2), 15.
- Amusa, K., & Leshoro, T. L. A. (2013). The Relationship between Electricity Consumption and Economic Growth in Botswana. *Corporate Ownership and Control*. <https://virtusinterpress.org/THE-RELATIONSHIP-BETWEEN,3122.html>
- APEC. (2013). *Distribution Transformer Survey: Estimate of Energy Savings Potential from Mandatory Efficiency Standards (MEPS)*. Asia Pacific Economic Cooperation.
- Asinyaka, M. (2019). Willingness to Pay for Energy Efficient Refrigerating Appliances in Accra, Ghana: A Choice Experiment Approach. *Review of Economics*, 70(1), 15–39. <https://doi.org/10.1515/roe-2018-0007>
- Atkins. (2016). *Renewable Energy and Energy Efficiency Strategy & Action Plan*.
- Baldwin, R., Cave, M., & Lodge, M. (Eds.). (2010). *The Oxford Handbook of Regulation*. Oxford University Press.
- BERA. (2021). *BERA Annual Report 2020/21* [Annual Report]. The Botswana Energy Regulatory Authority.
- BOBS. (2021). *BOBS Standards*. <http://www.bobstandards.bw/Pages/BOB-Standards.aspx?pid=0&mnusub=18&mp=0&sp=18>
- Botswana Energy Regulatory Authority Act, Pub. L. No. 13 (2016).
- Carbon Trust. (2018). *Cooling Efficiency Financing Case Studies*.
- Cardoso, R. B., Nogueira, L. A. H., & Haddad, J. (2010). Economic feasibility for acquisition of efficient refrigerators in Brazil. *Applied Energy*, 87(1), 28–37. <https://doi.org/10.1016/j.apenergy.2009.05.025>
- Danish Energy Management & Esbensen. (2017). *Renewable Energy Market Landscape Study covering 15 countries in Southern and East Africa* (Renewable Energy Market Landscape Study Volume 11). Danish Energy Management & Esbensen.
- Data Commons. (2020). *Botswana—Place Explorer—Data Commons*. https://datacommons.org/place/country/BWA?utm_medium=explore&mprop=amount&popt=EconomicActivity&cpv=activitySource%2CGrossDomesticProduction&hl=en
- de la Rue du Can, S., Leventis, G., & Shah, N. (2015). *Lessons Learned From Incentive Programs for Efficient Air Conditioners: A Review* (Research Report LBNL-191145).
- Deason, J., Leventis, G., Goldman, C. A., & Carvallo, J. P. (2017). *Energy Efficiency Program Financing* (LBNL-1005754, 1371723; p. LBNL-1005754, 1371723). <https://doi.org/10.2172/1371723>
- EBRD, & EC. (2020). *Centralised Energy Efficiency Financing Mechanisms: Policy Guidelines*. European Bank for Reconstruction and Development.
- Eil, A., Miller, A., Hillbrand, A., & Cheng, S. (2019). *Architecture & Financing Models for Efficient Cooling alongside the Montreal Protocol*.

- Essah, E. A., & Ofetotse, E. L. (2014). Energy supply, consumption and access dynamics in Botswana. *Sustainable Cities and Society*, 12, 76–84. <https://doi.org/10.1016/j.scs.2014.01.006>
- GEF, & U4E. (2017a). *Accelerating the Global Adoption of Climate-Friendly and Energy-Efficient Refrigerators* (U4E Policy Guide). United for Efficiency.
- GEF, & U4E. (2017b). *Accelerating the Global Adoption of Energy-Efficient Transformers* (U4E Policy Guide). UN Environment.
- Harutyunyan, N., & Sassi, M. (2017). *Promoting Green and Inclusive Investment in Kenya: Policies and Innovative Financing Models* (Policy Research Working Papers No. 7/01; p. 102). Cooperation and Development Network.
- Henderson, P. (2013). *On-Bill Financing Overview and Key Considerations for Program Design* (p. 7). Natural Resources Defense Council.
- How, A., & Kroes, G. (2018). *Botswana: Technical Market Review*. Climate Technology & Centre Network.
- IEA. (2019). *Botswana—Countries & Regions*. IEA. <https://www.iea.org/countries/botswana>
- IRENA. (2021). *Renewables Readiness Assessment: Botswana* (p. 94). International Renewable Energy Agency.
- Kumar, V. S., Prasad, J., Narasimhan, V. L., & Ravi, S. (2017). Application of artificial neural networks for prediction of solar radiation for Botswana. *2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, 3493–3501. <https://doi.org/10.1109/ICECDS.2017.8390110>
- Kumar, V. S., Prasad, J., & Samikannu, R. (2017). Computational linear model for predicting solar energy in Botswana. *2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS)*, 2371–2386. <https://doi.org/10.1109/ICECDS.2017.8389876>
- Letschert, V., McNeil, M., Ke, J., Kalavase, P., & Sampat, M. (2014). *Energy Efficiency Potential for Distribution Transformers in the APEC Economies* (LBNL-6682E, 1163743; p. LBNL-6682E, 1163743). <https://doi.org/10.2172/1163743>
- Magallón, D., Neve, J., Pillet, A., Motmans, T., Morais, L. M., & Lemoine, P. (2019). *Manual of Financing Mechanisms and Business Model*. Basel Agency for Sustainable Energy for UN Environment.
- Markandya, A., Labandeira, X., & Ramos, A. (2015). Policy Instruments to Foster Energy Efficiency. In *Green Energy and Efficiency: An Economic Perspective* (p. 23). Springer.
- Maswabi, M. G., Chun, J., & Chung, S.-Y. (2021). Barriers to energy transition: A case of Botswana. *Energy Policy*, 158, 112514. <https://doi.org/10.1016/j.enpol.2021.112514>
- Maswabi, M. G., & Kim, K. N. (2018). An Overview of the Development of Botswana’s Renewable Energy Policy Framework. *Bulletin of the Korea Photovoltaic Society*, 4(1).
- Ministry of Mineral Resources, Green Technology and Energy Security. (2021). *National Energy Policy* [Policy Instrument]. Ministry of Mineral Resources, Green Technology and Energy Security.
- Mooiman, M., Matlotse, E., & Molefhi, B. (2016, October 26). *A Review of Energy Efficiency Initiatives in Botswana*.
- Mukwaso, S. T. (2017). *Botswana electricity sector planning and CO₂ emissions reduction through solar PV in office buildings* [Thesis, The University of Waikato]. <https://researchcommons.waikato.ac.nz/handle/10289/12112>

- Munene, M. B., Odongo, J. O., & Nyambane, A. (2019). *Public Awareness, Strategies, Challenges and Opportunities* (p. 44). Heinrich-Böll-Stiftung.
- REN21. (2015). *SADC Renewable Energy and Energy Efficiency Status Report*. REN21.
- SE4ALL. (2012). *Botswana: Rapid Assessment and Gap Analysis*. Sustainable Energy for All.
- State and Local Energy Efficiency Action Network. (2014). *Energy Efficiency Financing Program Implementation Primer* (DOE/EE-1020, 1220861). Lawrence Berkeley National Laboratory. <https://doi.org/10.2172/1220861>
- Sustainable Energy for All. (2012). *Sustainable Energy for All: A Global Action Agenda* (p. 32). Sustainable Energy for All.
- Sustainable Energy for All. (2020). *Botswana: Rapid Assessment and Gap Analysis*. Sustainable Energy for All.
- The International Renewable Energy Agency. (2021). *Renewables Readiness Assessment: Botswana*. The International Renewable Energy Agency.
- The World Bank. (2019). *Population, total—Botswana | Data*. <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=BW>
- Thollander, P., & Palm, J. (2013). Policies Promoting Improved Energy Efficiency. In P. Thollander & J. Palm (Eds.), *Improving Energy Efficiency in Industrial Energy Systems: An Interdisciplinary Perspective on Barriers, Energy Audits, Energy Management, Policies, and Programs* (pp. 105–134). Springer. https://doi.org/10.1007/978-1-4471-4162-4_7
- UNIDO. (2017). *Overview of Renewable Energy and Energy Efficiency* [Training Package]. The United Nations Industrial Development Organization.
- V., S. K., Prasad, J., & Samikannu, R. (2018). Barriers to implementation of smart grids and virtual power plant in sub-saharan region—Focus Botswana. *Energy Reports*, 4, 119–128. <https://doi.org/10.1016/j.egy.2018.02.001>
- Venkatachary, S. K., Prasad, J., & Samikannu, R. (2017). Cost Optimization of Micro grids Using Homer: A Case Study in Botswana. *International Journal of Energy Economics and Policy*, 7(5), 323–339.
- Xavier, Y. M. de A., Guimarães, P. B. V., & Silva, R. K. C. da. (2020). *Energy Efficiency in Developing Countries* (1st ed.). Routledge.