United Nations Green Climate Fund (UN GCF) National framework for leapfrogging to Energy Efficient Appliances and Equipment in eSwatini (Refrigerators and Distribution Transformers) project
Technical Committee – Refrigerators
OVERVIEW

First TC Meeting 16/03/2022

Agenda

Time	Activity	Responsible
08:30 - 09:00	Arrival of Participants	All
09:00 - 09:10	Introductions	All
09:10 - 09:20	Opening Remarks	Department of Energy
09:20 - 10:20	Project Overview and Clarification	PEGASYS
10:20 – 11:20	Policy Working Group terms of reference and role	PEGASYS
11:20 – 11:40	Tea Break	
11:40 – 13:00	Discussion on the formation of the technical committees	All
13:00 – 14:00	Lunch	
14:00 – 15:00	Discussion on the consumer awareness campaign and funding mechanisms	PEGASYS
15:00 – 15:30	Organisation of the next meeting	All
	END OF EVENT	

Introduction

- Welcome
- Introductions (Igor Djurdjevic, Adesh Singh, Dr. Nicolette Mhlanga-Ndlovu, – Pegasys)
- Safety
- Important project and all stakeholders are critical to its success
- Success of the project depends on local buy in, participation and implementation – therefore thank you all for attending
- First PWG meeting – thereafter to be held quarterly (or more frequently if needed)

Project Overview

- Initiative between the United Nations Green Climate Fund (UNGCF) and the government of the Kingdom of eSwatini
- Project is simultaneously ongoing within 7 other countries of the SADC region, namely Botswana, Zimbabwe, Namibia, Malawi, Lesotho, Zambia and Tanzania
- **Aim** of the project is to focus on **distribution transformers** and **household refrigeration appliances** and establish a framework in order to **improve** the **energy efficiency** of these appliances
- To be done through the establishment of national standards for both refrigerators and distribution transformers
- Also through development of Minimum Energy Performance Standards (MEPS) as well as an energy labelling scheme for refrigerators

Project Overview

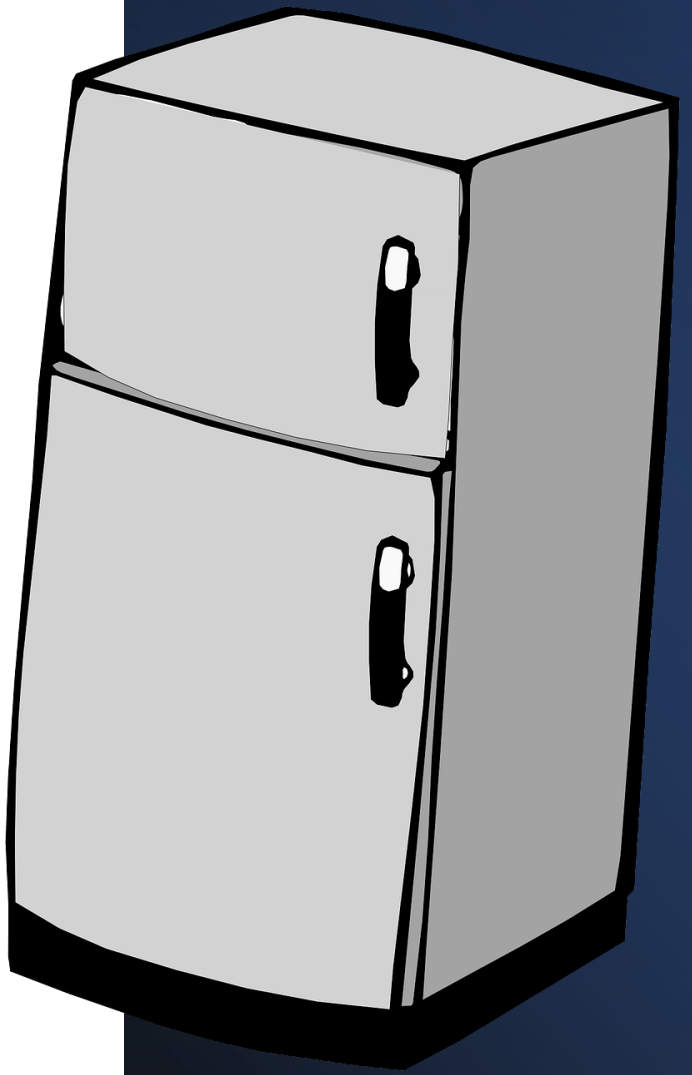
- To be executed through engaging key stakeholders within the country to create a system through which the necessary legislation can be developed related to the implementation of the MEPS
- Critical to the success is also a development of a national implementation plan
- The project will investigate the possible financing mechanisms available to assist the implementation
- Respective training programmes to enable transition into a self-sustained and managed implementation of the project in the future will be implemented
- Pegasys was contracted by the UNEP through the Climate Technology Centre and Network to implement this initiative in eSwatini

Project Overview – Market Assessment

- Market assessment completed through data gathering via various sources including:
  - Household interviews
  - Publicly available information (e.g. desktop study)
  - Information provided by eSwatini stakeholders
  - Interviews with retailers and other entities
- Important information gained regarding the current baseline of energy efficiency and hence the possible improvements and impact
- Information also gathered regarding the key stakeholders and internal processes to be followed for most effective implementation

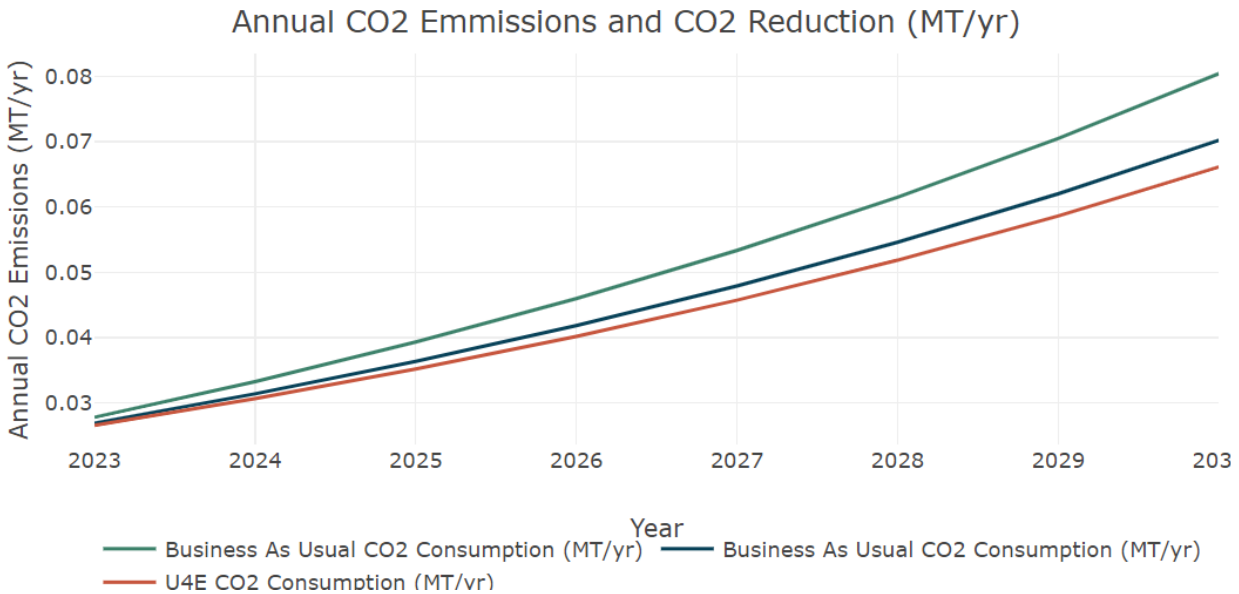
Project Overview – Market Assessment - Refrigerators

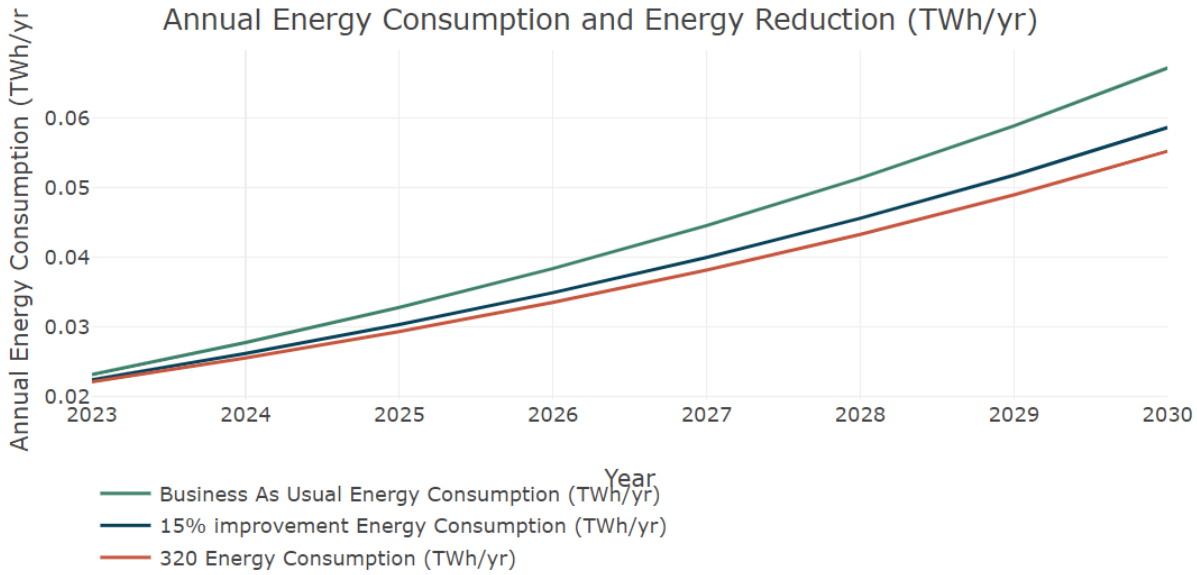
- Main Observations
  - Energy efficiency is not one of the main purchasing decision drivers when it comes to refrigerators.
  - The majority of the refrigerators are the fridge/freezer combo sets
  - The majority of households have one refrigerator
  - Some micro enterprises (small shops) make use of a refrigerator (typically small chest freezers)
  - The majority of new appliances have the R600a refrigerant
  - The majority of the refrigerator volume is around the 300 – 350 litre mark
  - None of the respondents were aware of any energy efficiency schemes available
  - The majority of respondents indicated that they would not be willing to pay extra for increased energy efficiency



Project Overview – Market Assessment - Refrigerators

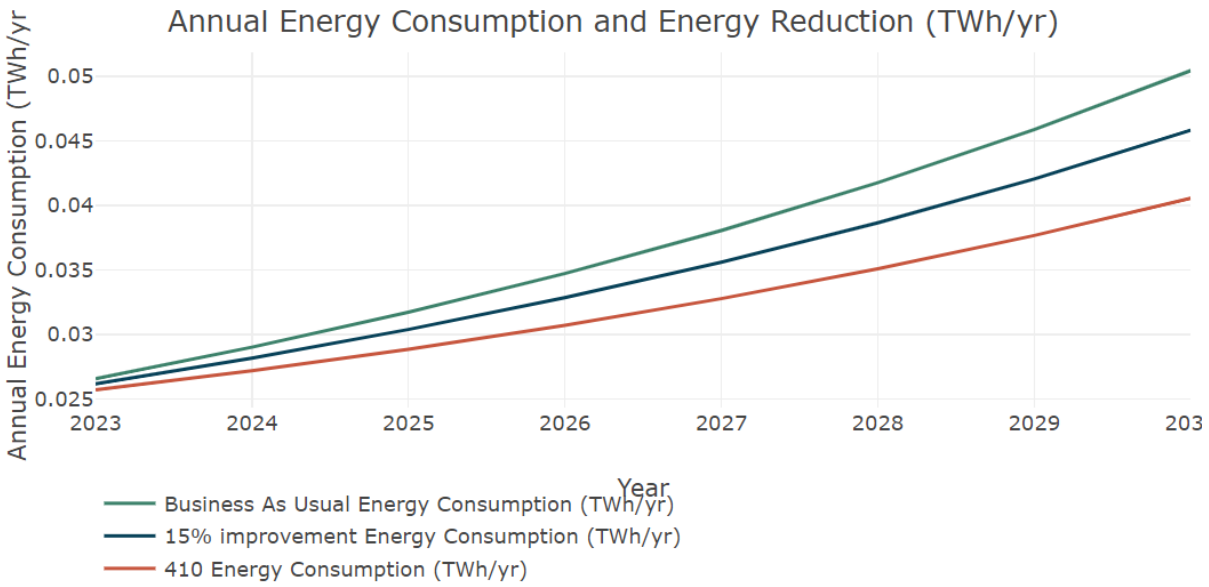
- Fridge/freezer combination sets

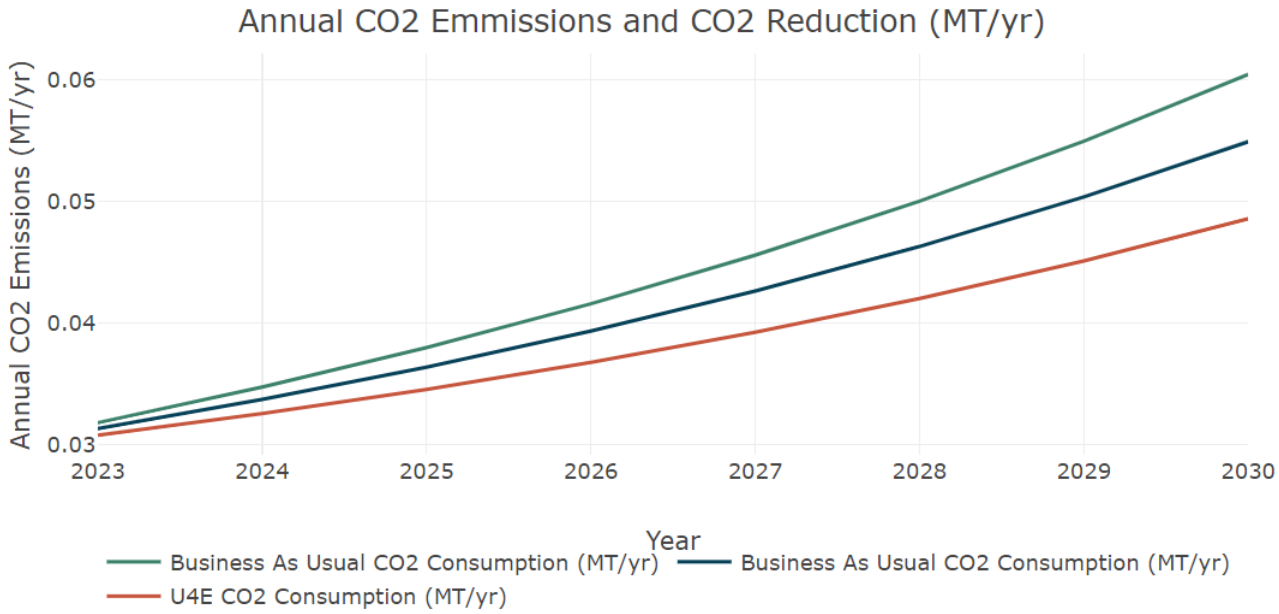




Project Overview – Market Assessment - Refrigerators

- Chest freezers



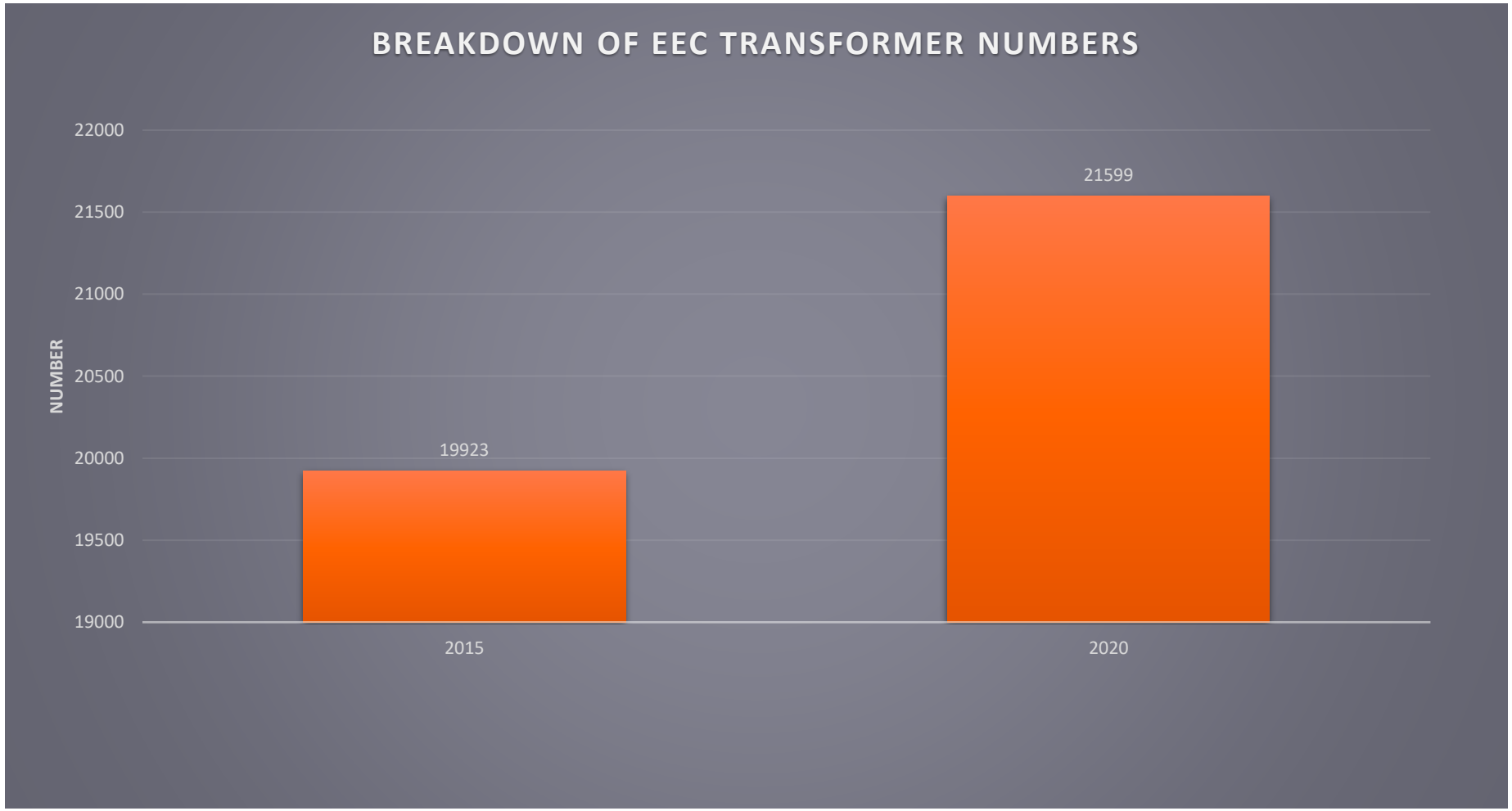


Project Overview – Market Assessment – Distribution Transformers

- A total of 21599 transformers were analysed - based on the database provided by the EEC.
- Transformer sizes vary between 16 kVA and 2500 kVA.
- The transformer manufacturers are not listed in the database
- Importation data indicates that the bulk of transformers on the EEC network are sourced from South African manufacturers.
- The economic study used the following standards: SANS 780 2009; SANS 780 2019 &IEC TS 60076-20

- **Assumptions for the study:**
  - The high voltage rating of the transformer was 24 kV. The no-load, load and efficiencies were taken for this rating.
  - The transformer parameters were three phase parameters for transformers equal to , or greater than 25kVA, and single phase for less than 25kVA.
  - For non-standard power ratings, the no-load, load and efficiencies were related to the nearest standard category.
  - All transformers employed a CRGO core, and zero transformers made use of an amorphous core.

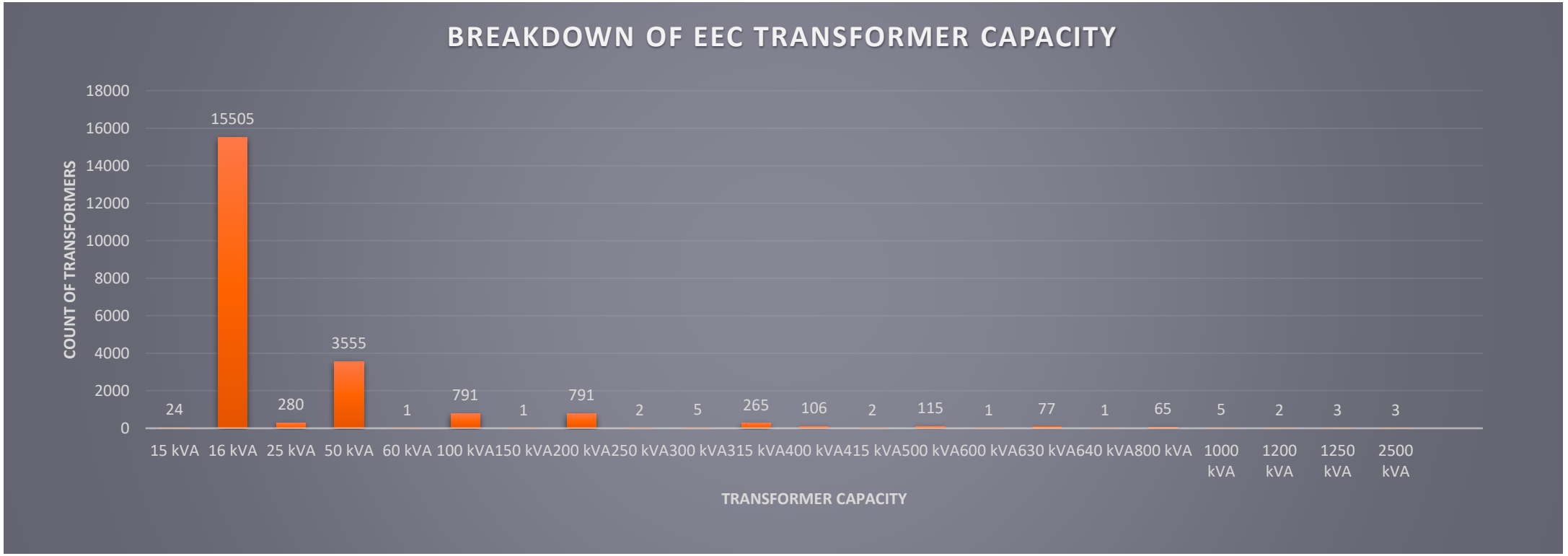
Project Overview – Market Assessment – Distribution Transformers



- 1676 transformers added in 5 years at 335 new transformers a year
- Corroborates highest access to electricity per capita in Sub-Saharan Africa
- ~2 % growth in the transformer base per year

Project Overview – Market Assessment – Distribution Transformers

The figure below shows the count of EEC transformers categorised according to their capacity. The EEC consists mainly of 16 kVA and 50 kVA transformers, which make up more than 50% of their total transformer base. The database provided by the EEC was well maintained with only 21 transformers missing information pertaining to the kVA rating. For the purposes of the study, the unknown transformers were assigned kVA ratings in proportion to the known transformers.



Project Overview – Market Assessment – Distribution Transformers

In very simple terms, the Transformer Efficiency is given by the equation

$E = (S-L)/ S$

$E = (S-(PL+PO)/ S$

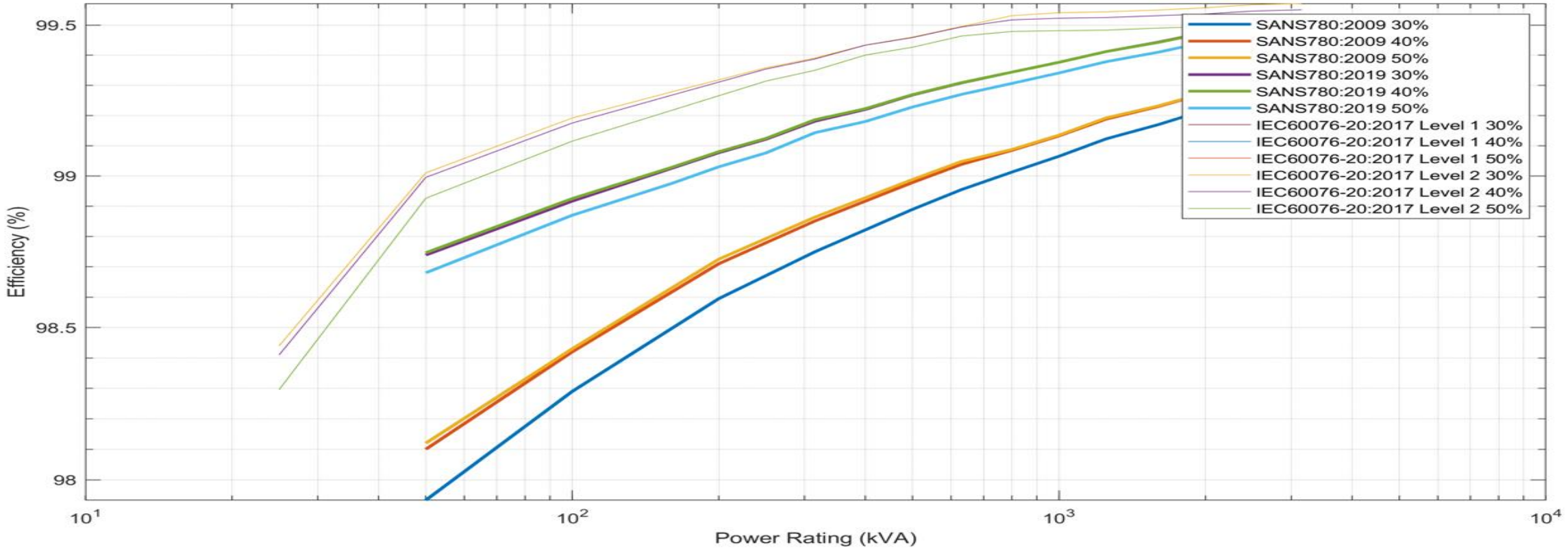
Where :

E= efficiency
S = defined power
L = sum of no-load losses, load losses
PL = Load losses that vary with the transformer load i.e usage/current drawn
PO = No Load losses than are continuously present provided that the transformer is energized.

Project Overview – Market Assessment – Distribution Transformers

The transformers in the EEC network are specified mostly to the SANS 780 specification. Until 2019 when it was revised, the maximum allow losses (& hence ***minimum efficiencies***) remained unchanged since the 1960's. Below we compare the efficiencies of transformers according to the SANS and IEC standards.

When compared with the IEC60076-20, SANS780:2019 is similar to the level 1 efficiencies, with level 2 being high performance transformers. These efficiencies are shown in the figure below.



Project Overview – Market Assessment – Distribution Transformers

The table below shows the annual energy losses for the EEC fleet for loadings of 30%, 40 % and 50%, according the relevant SANS and IEC standards. Transformers specified to SANS780:2019 or IEC60076-20 Level 1 result in a significant energy loss reduction when compared to SANS780:2009. A further reduction would be achieved by transformers specified to IEC60076-20 Level 2.

Loading	Total transformers	Energy Losses			
		SANS780:2009	SANS780:2019	IEC60076-20:2017 Level 1	IEC60076-20:2017 Level 2
30 %	21,599	49,457 MWh	27,740 MWh	36,836 MWh	28,957 MWh
40 %		59,724 MWh	36,394 MWh	51,868 MWh	39,226 MWh
50 %		72,926 MWh	47,520 MWh	71,196 MWh	52,428 MWh

The table below lists the annual energy losses for 5%, 10% and 15% growth of the network. The load factor used was 0.4. The table demonstrates towards the energy efficient specifications would result in significant energy loss reduction.

New Transformer Growth	Total transformers	Energy Losses			
		SANS780:2009	SANS780:2019	IEC60076-20:2017 Level 1	IEC60076-20:2017 Level 2
0%	21,599	59,724 MWh	36,394 MWh	51,868 MWh	39,226 MWh
5 %	26,253	72,595	44,237 MWh	63,046 MWh	47,679 MWh
10 %	31,622	87,443	53,284 MWh	75,940 MWh	57,430 MWh
15 %	37,775	104,458	63,653 MWh	90,718 MWh	68,606 MWh

Project Overview – Market Assessment – Distribution Transformers

The total cost of ownership is an important concept when purchasing a transformer.
The capitalisation cost of losses is a method for quantifying what the better purchase of a transformer is. An example study on the capitalisation costs of a 50 kVA transformer is completed and is shown below. The capitalisation cost accounts for the cost of the losses over the lifetime of the transformer and is used by utilities to determine the most cost-effective transformer over its lifetime.

TCO = initial cost + capitalised losses [(A x iron loss kW) + (B x copper loss kW)]

Key parameters considered for this study were:
•A load factor of 0.4
•Economic life of 30 years
•Energy price of 39 EUR/MWh
•Hours operational per year of 8760 hours

These parameters resulted in:
•A capitalisation of no load losses factor, A, of 4.24
•A capitalisation of load losses factor, B, of 0.68
The results comparing the transformers according the to the specifications in SANS780:2009, SANS780:2019 and IEC60076-20:2017 are shown in the table below. It is evident that the savings presented by the higher efficiency specifications result in significant savings over its lifetime. (Note the purchase price has not been included here).

Parameter	SANS780:2009	SANS780:2019	IEC60076-20:2017 Level 1	IEC60076-20:2017 Level 2
No load loss	220 W	110 W	90 W	81W
Load loss	90 W	79.2 W	99 W	67.5 W
Energy no load loss per annum	1.9 MWh	1.0 MWh	0.8 MWh	0.7 MWh
Energy load loss per annum	0.8 MWh	0.7 MWh	0.9 MWh	0.6 MWh
Energy cost per annum	EUR 106	EUR 65	EUR 65	EUR 51
Capitalisation of Losses Cost	EUR 994	EUR 520	EUR 449	EUR 389

The analysis of the transformers in service on the Eswatini grid shows that Eswatini stands to benefit financially and environmentally should higher efficiency distribution transformers in conjunction with the capitalisation of transformer losses be adopted as a norm.

Findings of the market assessment

- The majority of refrigerators in Eswatini are fridge/freezer combination sets and chest freezers
- The dominant refrigerant in Eswatini is R600a, especially in new appliances
- There is a significant energy saving to be gained for both consumers and the country in general by moving towards energy efficient appliances
- There is a general lack of awareness of the positive impact of energy efficient refrigerators and the positive financial impact over the lifetime of the refrigerator
- The EEC is the main user of distribution transformers in Eswatini
- Currently the EEC purchases distribution transformers based on up-front cost alone and the total cost of ownership is not considered
- The market assessment shows that Eswatini stands to benefit financially and environmentally should higher efficiency distribution transformers in conjunction with the capitalisation of transformer losses be adopted as a norm.

PWG terms of reference

- As a recap, the project activities include:
- Development of national policy roadmaps and regulatory framework, including:
- Development of Minimum Energy Performance Standards (MEPS), High Energy Performance Standards (HEPS) and a MV&E framework for residential refrigerators and distribution transformers.
- Development of a labelling scheme, consumer awareness approach as well as organization of a capacity building for custom officials for residential refrigerators.
- Organization of end-user education as well as capacity building on total cost of ownership for distribution transformers.
- Identification and development of financial mechanisms and options for the promotion of higher efficiency residential refrigerators and distribution transformers.

PWG terms of reference

- Policy Working Group is established to provide a guidance in ensuring coherence with national energy efficiency policies and act as steering committee for the project
- The objective and mandate of the Policy Working Group is to ensure coherence and synergy between the national policy roadmap and the regulatory framework to be developed and the national policies on energy efficiency
- The Policy Working Group is to develop the national policy roadmap for refrigerators and the national policy roadmap for distribution transformers. The national policy roadmaps include the following::
  - Minimum Energy Performance Standards (MEPS) and Higher Energy Performance Standards (HEPS)
  - Labelling options and decide on labelling scheme
  - End-users awareness campaign
  - Public consultations
  - MV&E plan
- The specific task of the PWG is in this context to guide the development of the above-described activities, as well as to oversee the TC

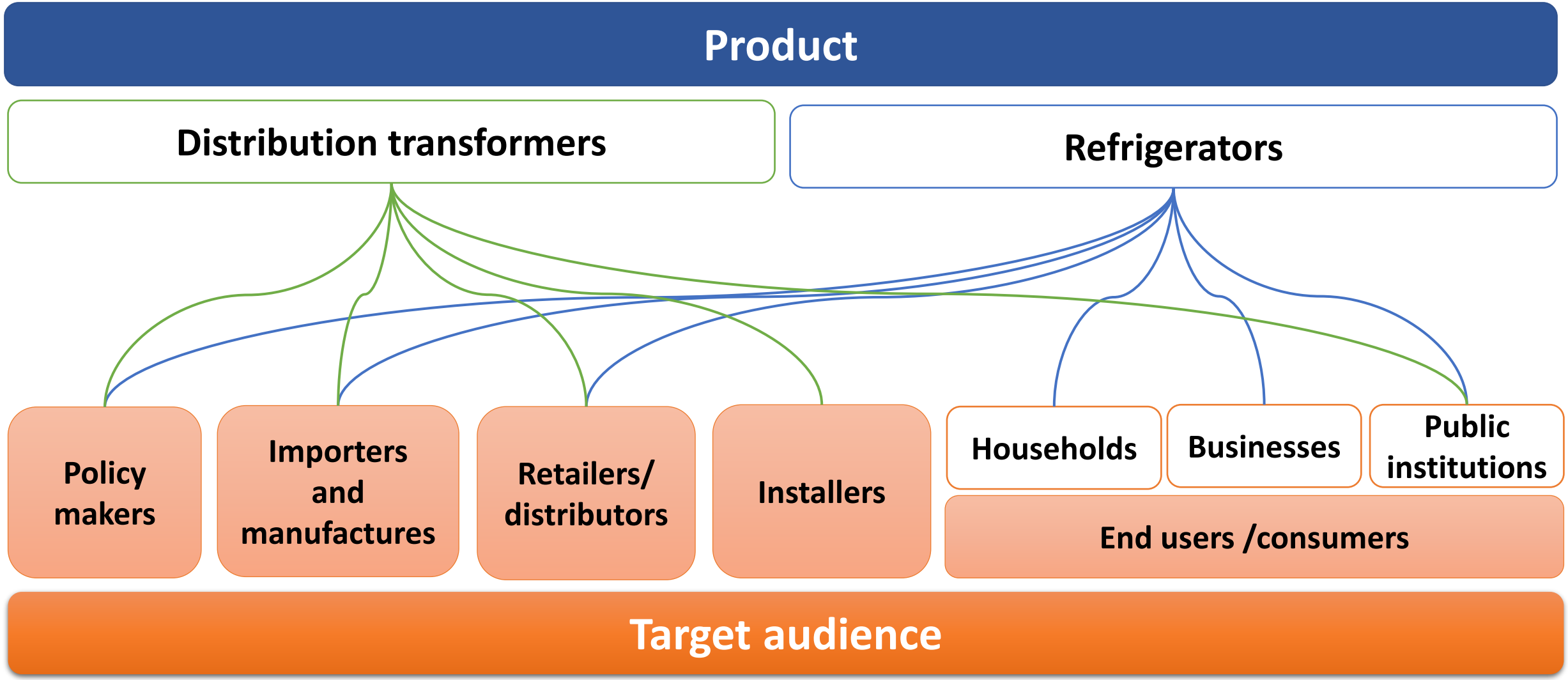
PWG terms of reference

- The PWG will meet on a quarterly basis during which the work will be conducted by the PWG with support from the experts team led by Pegasys, and in coordination with UNEP-U4E and CTCN
- Pegasys will act as secretariat to the PWG, and in this capacity organize PWG meetings, prepare minutes of PWG meetings, prepare quarterly progress reports
- Pegasys will be responsible for organizing the PWG meetings and carrying out all the necessary activities to support the development of the national policy roadmaps, including: meetings, workshops, seminars, technical assistance, study preparation, capacity building
- The PWG will be responsible for the review and approval of all the intermediate deliverables until the national policy roadmaps
- The PWG will in addition oversee the work of the technical committee for refrigerators (TC-Ref) and of the technical committee for distribution transformers (TC-DT).

Formation of Technical Committees

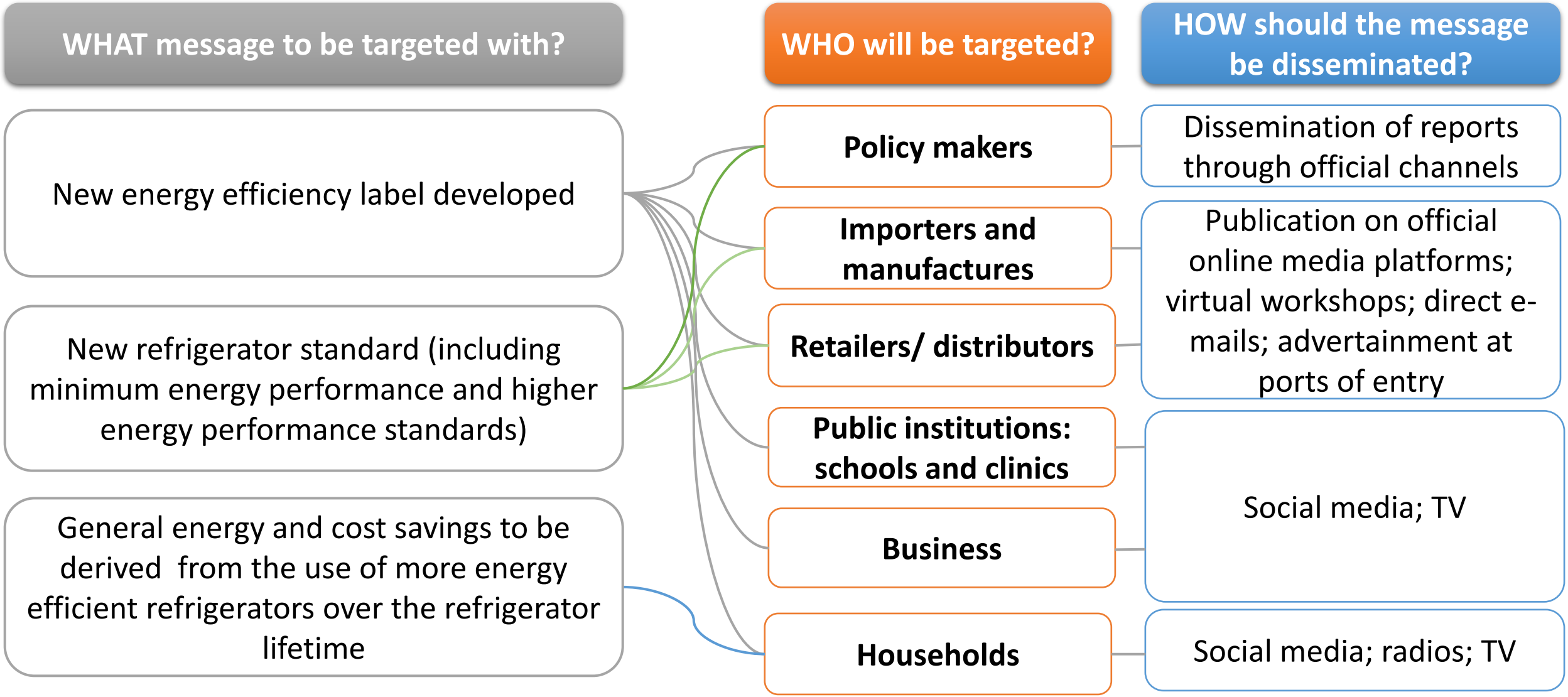
- Two separate technical committees to be formed, one for refrigerators and one for distribution transformers
- To be guided by the eSwatini Standards Authority and its processes and policies
- Important that the members have relevant technical expertise
- Critical that there is no personal, organisational or financial agenda or motivation for participants
- First meeting of respective TCs?

Public Awareness Campaigns: products vs targeted audiences



Public Awareness Campaigns: distribution transformer

Public Awareness Campaigns: refrigerator



Financial Support Mechanisms - Refrigerators

- There are 2 main types of scenarios to consider for financing of household refrigerators
  - Pure financing mechanism – loan for new refrigerators
  - Replacement of refrigerators – loan for replacement
- Does replacement make sense in the context of Eswatini? What about recycling?
- Main possibilities for consumers are on-wage financing and on-bill financing
- Such initiatives have also been implemented in West Africa (Ghana and Senegal) in previous projects

Financial Support Mechanisms – Refrigerators On-wage financing

- On-wage financing – loan provided to persons with stable salary/income
- Suppliers/retailers need to qualify for the programme and ensure they provide highly energy efficient refrigerators
- Usually suppliers also dispose of old, inefficient refrigerators
- Financing includes: Financial institutions (e.g. banks), consumers, employers, suppliers
- Employers make arrangements with financiers (guarantee the repayment of loan)
- Financiers have arrangements with qualifying suppliers
- Consumers receive refrigerators from selected suppliers (suppliers usually dispose of old refrigerators)
- Consumers pay for refrigerators through a repayment from wages (0% interest in Ghana)

Financial Support Mechanisms – Refrigerators
On-bill financing

- On-bill financing – loan provided to persons by the electricity supplier (EEC)
- Suppliers/retailers need to qualify for the programme and ensure they provide highly energy efficient refrigerators
- Credit institutions (e.g. banks) have a relationship with the EEC to supply finds for the purchase of new refrigerators
- Consumers pay back the loan through their electricity bill (amount added to the bill monthly)
- Default on loan means the termination/suspension of service (e.g. cutting off electricity)
- Can also include the recycling scheme
- Consumers can be verified according to criteria (e.g. credit record) to qualify for the loan

Financial Support Mechanisms – Distribution Transformers

- Few major utilisers of distribution transformers in the country, vast majority with the EEC
- Capital required to purchase new, more efficient DTs
- EEC imports electricity – therefore savings on imports are a direct replacement of capital costs
- Direct loans can be taken with major banks in the region
- Other financing mechanisms exist that include transformer suppliers
- Shared savings model – Supplier pays for initial cost and installation and gets a percentage of the energy savings back in repayments over time
- Guaranteed savings model – Supplier is paid full amount but guarantees energy savings and has to reimburse utility if savings not met (can be complicated to measure and implement and capital investment by utility still required)
- Also possible to procure in bulk but insisting on Total Cost of Ownership

Planning future project phases

- Formation of relevant Technical Committees
- Development of National Standards and MEPS
- Development of the labelling scheme
- Public awareness campaign
- Training
- Implementation plan
- Finalisation of financial support mechanisms

Next meeting

- Next meeting to be held on?
- Questions/comments
- Closing

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