Energy Efficiency for Equipment (Distribution Transformers)

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Soledad GARCIA
International Energy Efficiency consultant
United for Efficiency

Mayur KARMARKAR
International Technical Equipment expert
International Cooper Association

Supporting Countries to Save 20% of their Electricity

By accelerating the Global Transition to **much more energy efficient lighting and appliance technologies** by strengthening country capacities around the world, as well as ensuring environmentally sound management practices. Building synergies among stakeholders, sharing knowledge and information, helping create strategic policy and regulatory frameworks, and addressing technical and quality issues.

Electric Motors

Light Bulbs

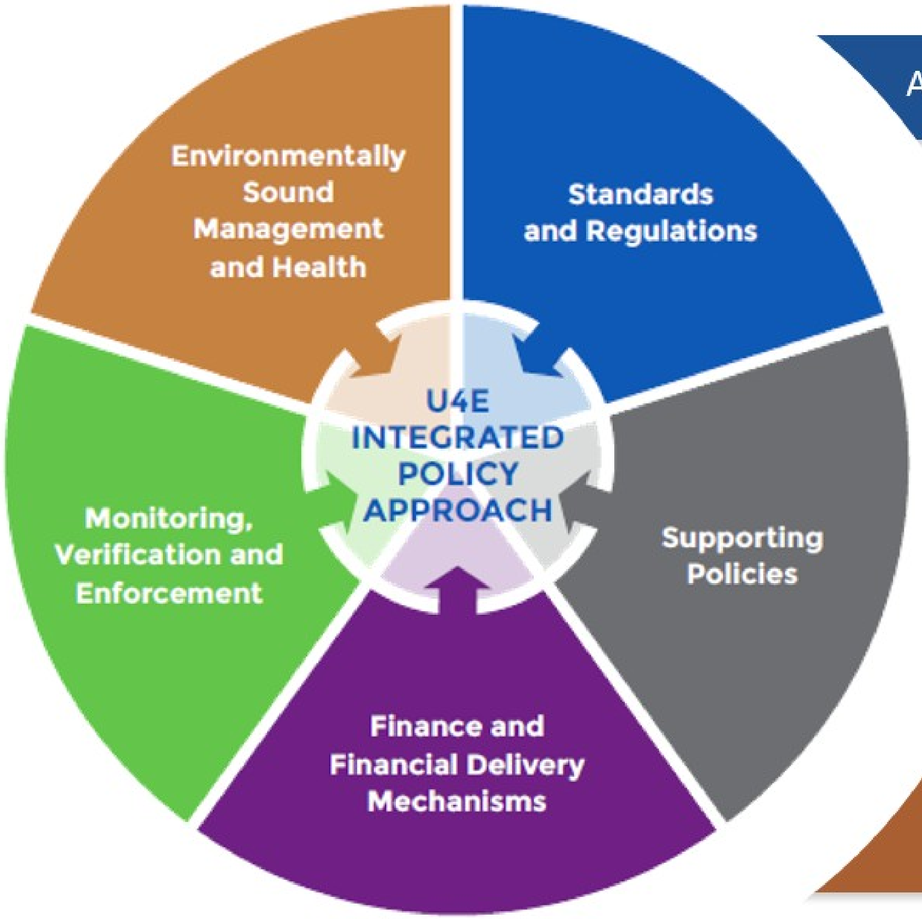
Residential Refrigerators

Room Air Conditioners

Distribution Transformers

U4E Integrated Policy Approach

U4E implements a proven *Integrated Policy Approach* for product market Transformation



Adopt minimum energy performance and internationally-recognized test standards

Ensure effective labels are in place and that appropriate consumer information and advice is available

Consider a blend of financing mechanisms and incentives to help offset the incremental costs of energy-efficient products

Include legal authority, enforcement powers, capacities and penalties in the national legal and enforcement frameworks;
Use a product registration system as an initial compliance gateway

Provide for Materials Recovery (e.g. glass, ferrous and nonferrous metals and phosphors including any mercury in lamps and refrigerant gases).

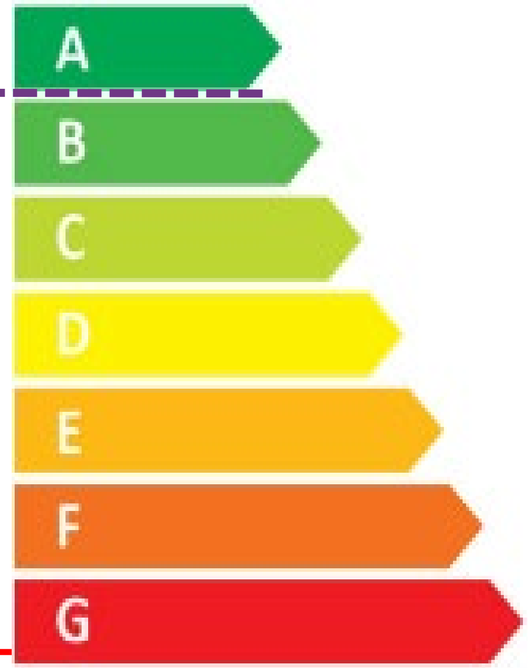
Fulfilling our Mission: Standards, Labelling and Incentives

Energy Efficiency of Products in the Market

Offer incentives support the adoption of the best products (e.g. rebates, financing schemes, bulk procurement, etc)

Promote efficient products (e.g. labels and awareness campaigns to help buyers understand EE benefits)

Minimum Energy Performance Standards (MEPS) ban the worst products



Monitor the market for MEPS compliance, test the products and enforce the rules

+

ESM for Recycle & dispose old products in a sustainable way

Project Partners:

MANUFACTURERS & INDUSTRY ASSOCIATIONS

OSRAM · SANHUA · International Copper Association (Copper Alliance) · GREE · Electrolux · mabe · B/S/H/ · arçelik · Whirlpool Corporation · ABB

TECHNICAL ORGANISATIONS & INITIATIVES

Berkeley Lab · olade (Organización Latinoamericana de Energía | Latin American Energy Organization | Organização Latino-Americana de Energia | Organisation Latino-Américaine d'Énergie) · Copenhagen Centre on Energy Efficiency (SE4ALL EE Hub) · SACREEE (SADC Centre for Renewable Energy & Energy Efficiency) · RCREEE (Regional Center for Renewable Energy and Energy Efficiency) · EACREEE (Building a Sustainable Energy Future)

giz · clasp · African Energy Commission · NRDC · GELC · Carbon Trust · IIEC (International Institute for Energy Conservation)

BASE · AMBILAMP (Reciclamos la luz) · ASEAN Centre for Energy (ACE) · topten · EESL · 4E · NIS

FUNDERS, FINANCIERS & IMPLEMENTING AGENCIES

UN environment (United Nations Environment Programme) · UNDP · gef · KIGALI Cooling Efficiency Program · Green Climate Fund · Banque Africaine de Développement (African Development Bank) · Sida (Swedish International Development Cooperation Agency) · Global Climate Partnership Fund (managed by responsAbility) · Development Bank of Rwanda (www.brd.rw) · BRD (We empower you)

U4E Scope of Support:

U4E provides support at various levels. Currently presente in more than 30 countries with both Regional and Country projects

GLOBAL

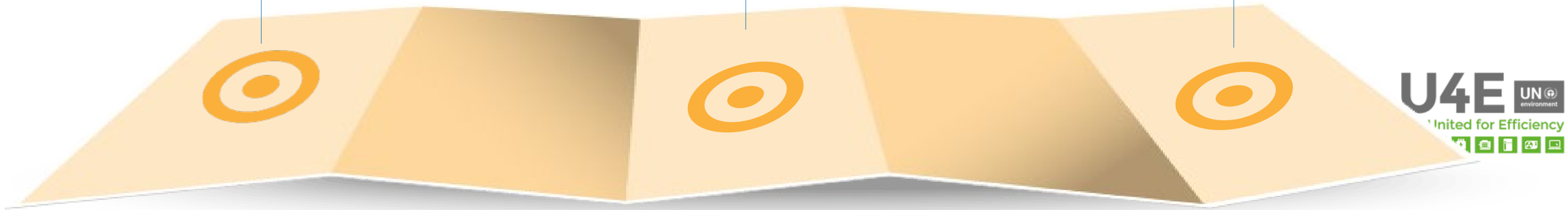
- 155 Country Savings Assessments
- 6 Policy Guides
- 5 Model Regulation Guidelines
- Product Registry System
- Communications and outreach
- www.united4efficiency.org

REGIONAL

- Regional Market Assessments
- Regional Capacity Building for Policy Makers
- Regional Harmonization Activities.

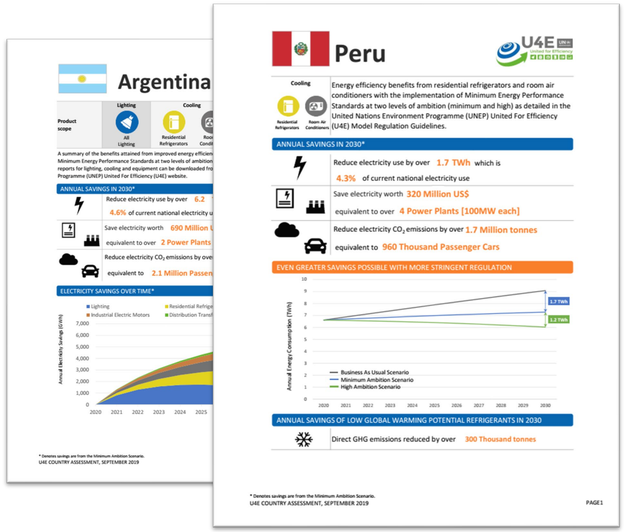
NATIONAL

- National Strategies
- National Training for Policy Makers and Practitioners
- Implementation Technical Assistance
- Project development and Fund rising support



U4E International Tools & Resources

+155 Country Saving Assessment

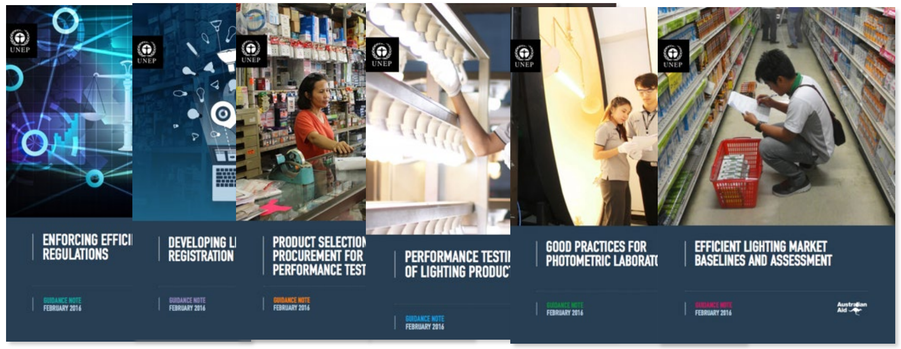


Procurement Specifications Guideline and Financial Manuals

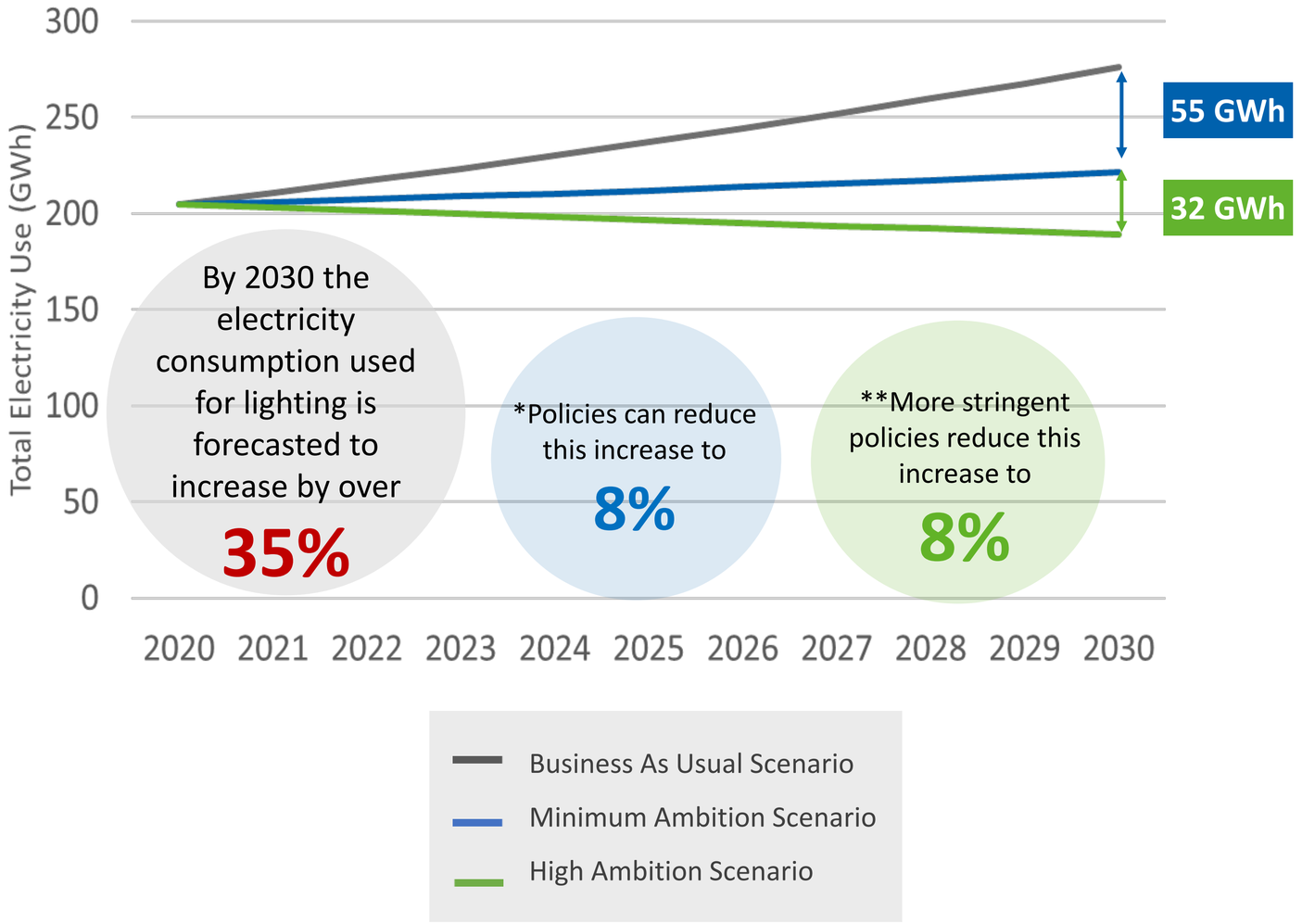
5 Policy Guides for selected products

Model Regulation Guidelines

Monitoring, Verification and Enforcement Guides



Saving Opportunities in Mozambique from Energy-Efficient Transformers



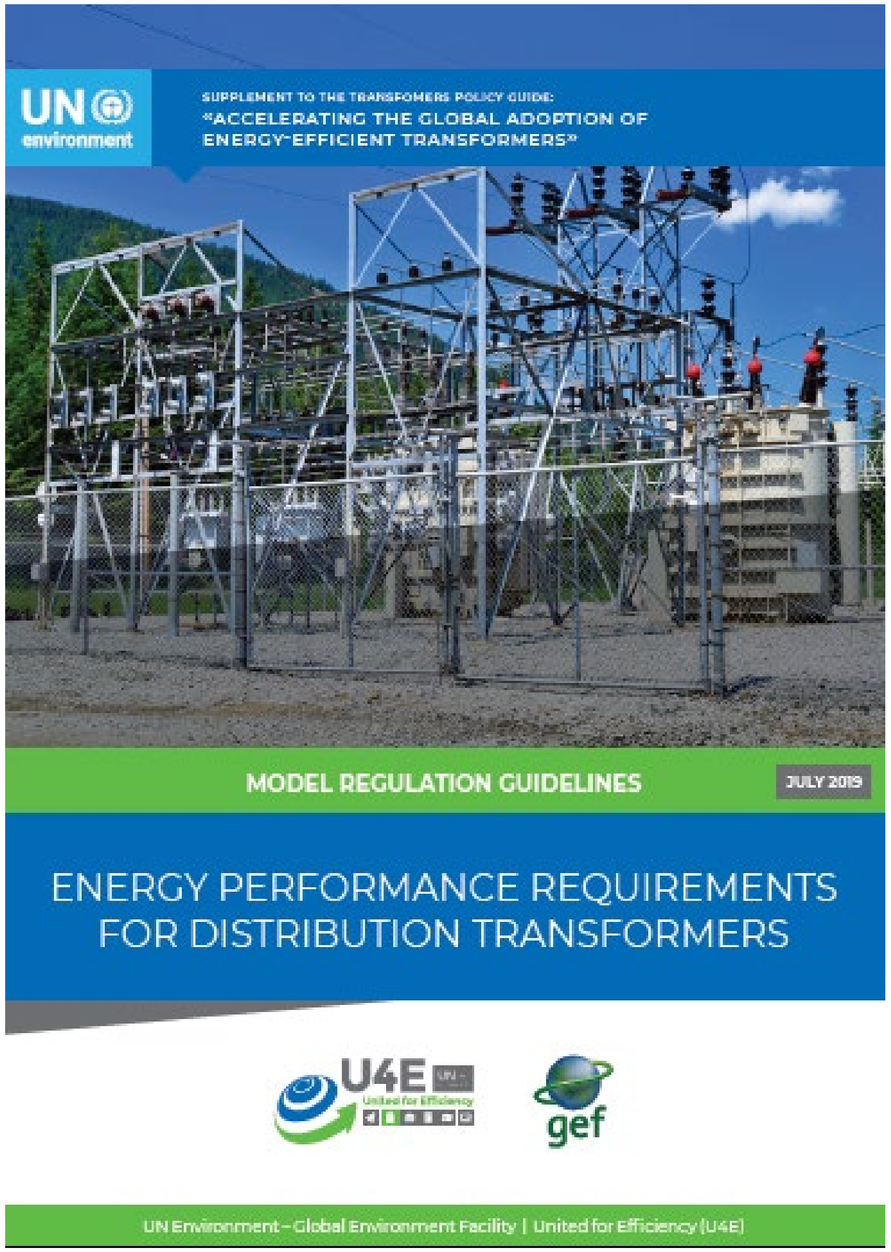
Annual Savings in 2030* from Energy Efficient Lighting:

55 GWh of electricity consumption, which is equivalent to:

- **35** Thousand tonnes of **CO_2**
- **3** Million **USD on electricity bills**

*Minimum Ambition Scenario

1. Achiving Savings through EE Tranformers



Energy-Efficient Transformers Policy Guide

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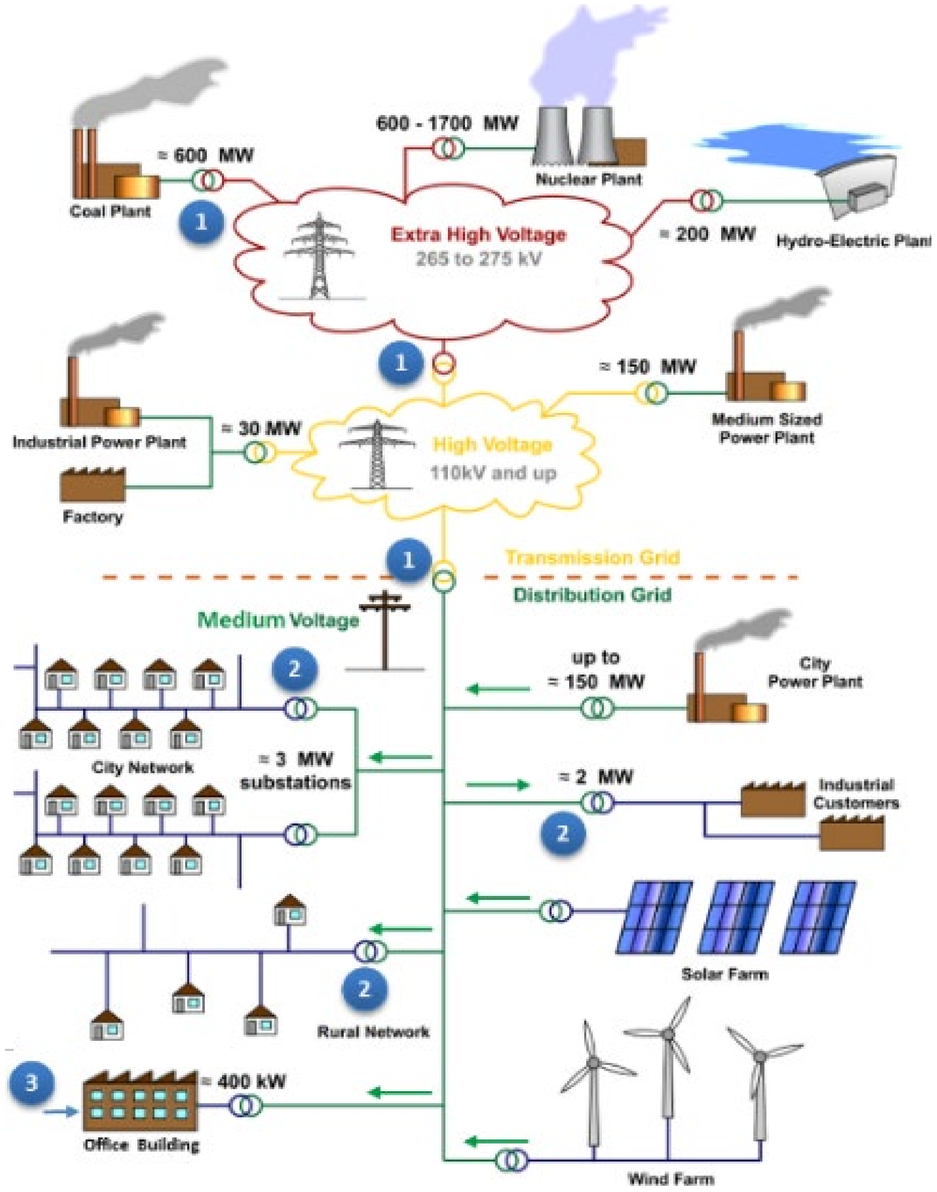
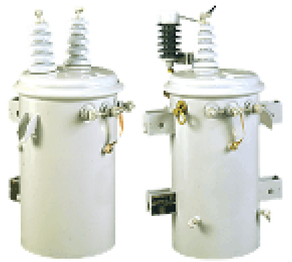
Transformers energy and environmental impact



- **Static devices that transfer electrical power between circuits**
  - Losses proportional to current in wire: increase voltage & decrease current
- **Huge impact on energy, environment**
  - Operate non-stop
  - Lifetimes of 25 years or more
  - Lose nearly 5% of global electricity
  - Stock will nearly double by 2030

Focus of the Policy Guide

Main Power Transformers



Distribution Transformers

Group	Voltage	Phases	Insulation	Common Use
Large Power	>245 kV	Single & Three	Liquid-filled	Step up or down voltage for transmission over long distances; substation transformers
Medium Power	>36 kV & ≤230 kV	Single & Three	Liquid-filled or dry-type	Stepping voltages down from a sub-transmission system to a primary distribution system
Medium Voltage Distribution	≤36 kV	Single & Three	Liquid-filled or dry-type	Step down voltage in a distribution circuit from primary to secondary voltage
Low Voltage Distribution	≤1 kV	Single & Three	Dry-type	Step down voltage in a building distribution circuit or to supply power to equipment

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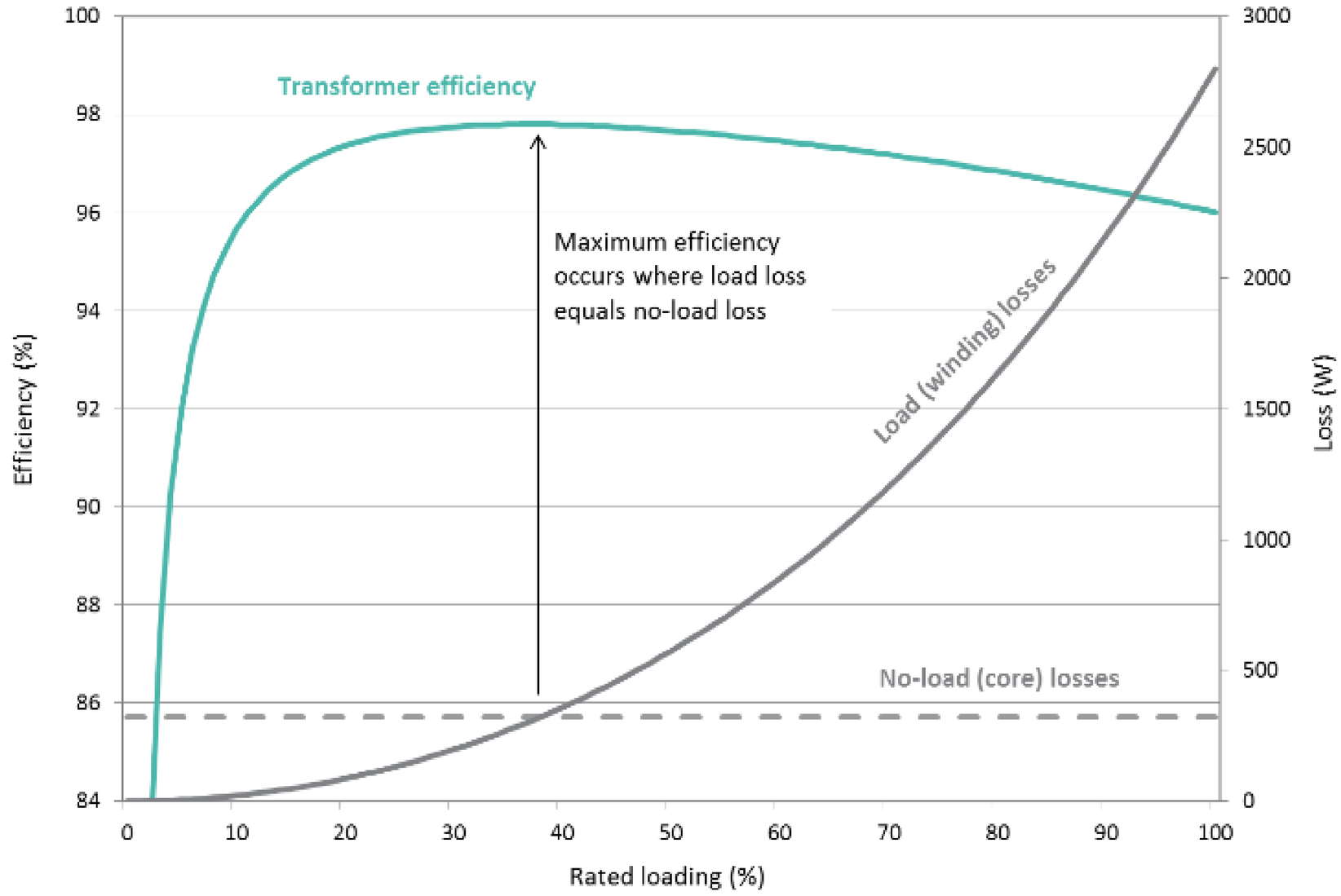
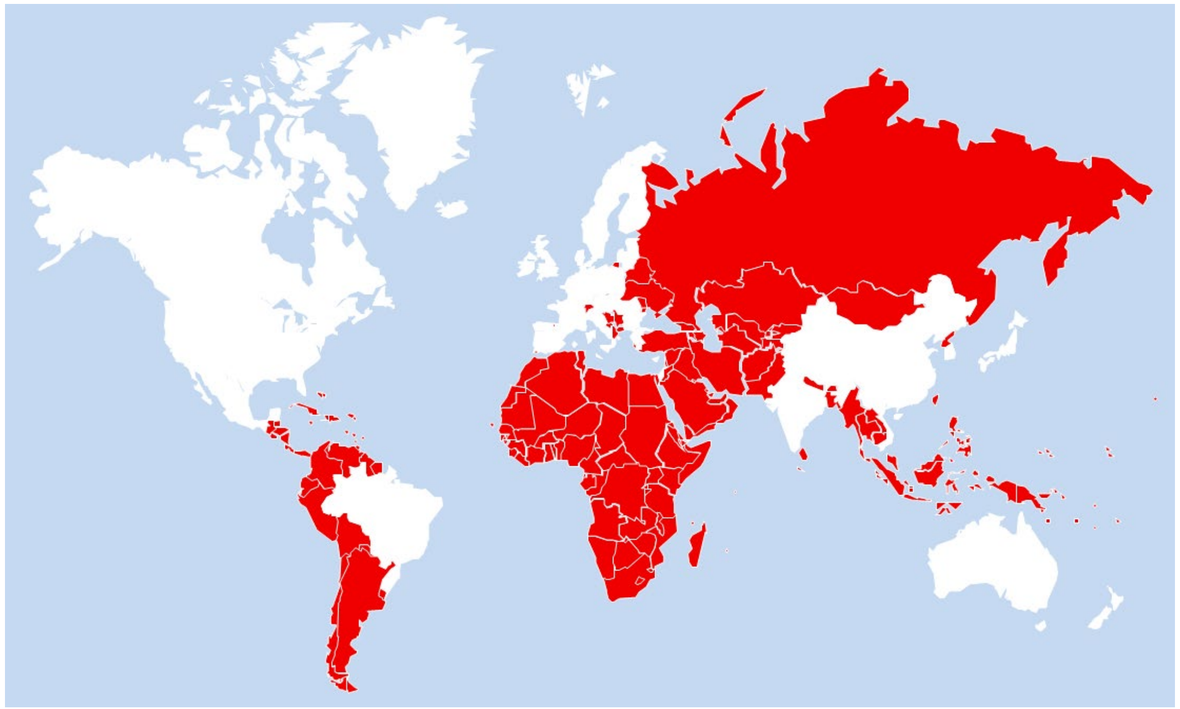
Loss and Efficiency Relationship



Why Leapfroging to Energy-Efficient Transformers?

13 of the world's largest economies undergoing a Market Transformation

- Very attractive when considering the total cost of ownership
- Significant risks of inaction: lock-in decades of electricity waste
- Savings potential: **400 TWh** and **250 million tonnes** of CO_2 emissions in 2030



Countries (in red) lacking national mandatory efficiency policies for distribution transformers

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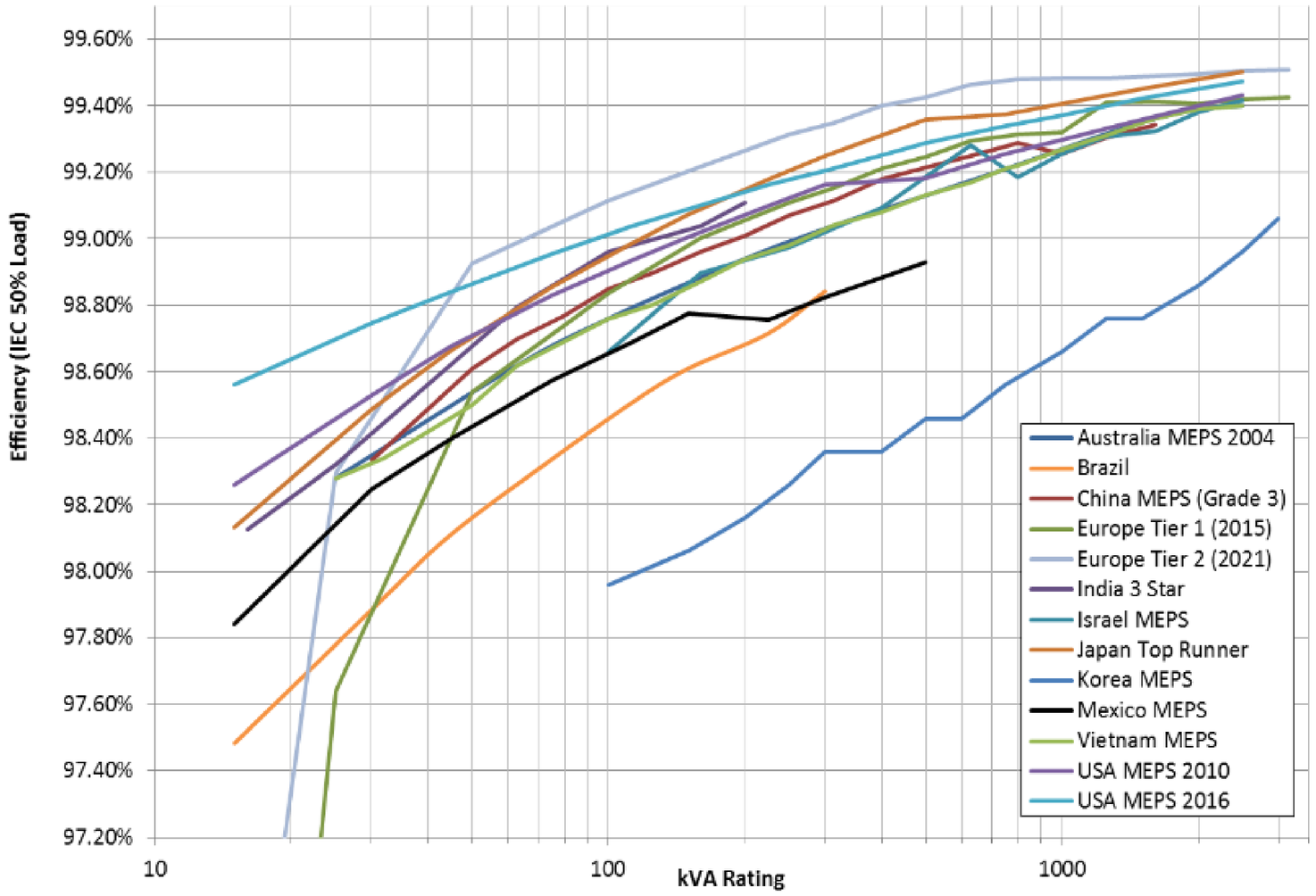
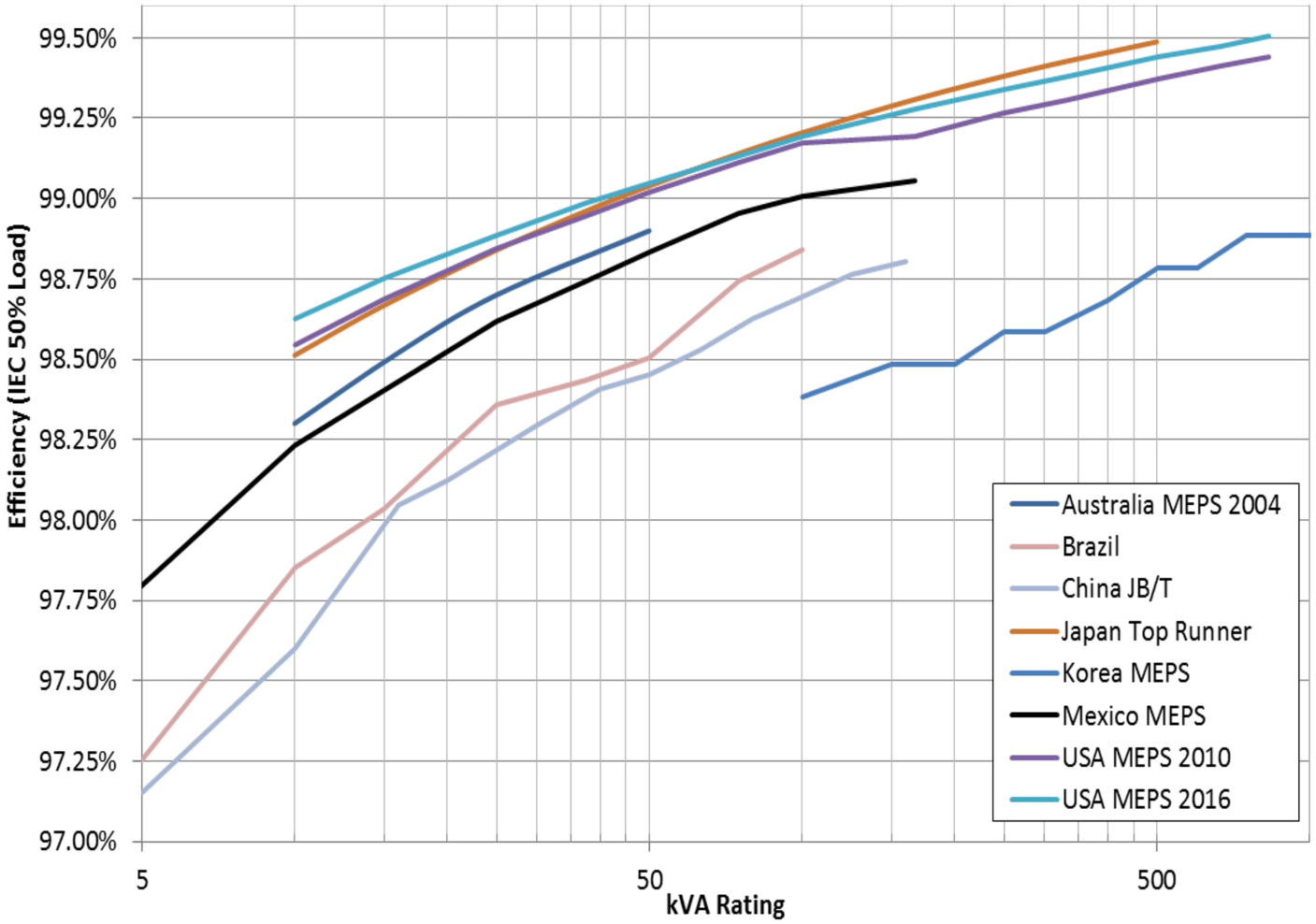
Examples of MEPS for Transformers



Three-Phase Liquid-Filled Transformers

Source: SEAD Standards & Labelling Working Group Distribution Transformers Collaboration. Part 1: Comparison of Efficiency Programmes for Distribution Transformers. December 2013

Examples of MEPS for Transformers



Single-Phase Liquid-Filled Transformers

Source: SEAD Standards & Labelling Working Group Distribution Transformers Collaboration. Part 1: Comparison of Efficiency Programmes for Distribution Transformers. December 2013

Sample Recommendations for Policymakers

Standards

✓ Aim to adopt MEPS with test method IEC 60076

Supporting Policies

✓ Labels
✓ Communication campaigns

Monitoring, Verification and Enforcement

✓ Implement MVE in national legal framework in time for the adoption of MEPS

Financial Mechanisms

✓ Encourage the adoption of purchasing practices that are based on the total cost of ownership over a transformer’ s lifetime, rather than on the first cost.

Environmentally Sound Management and Health

✓ Follow guidance from the Stockholm Convention on Persistent Organic Pollutants for locating, handling and disposing of PCB contaminated equipment

Distribution Transformer Model Procurement Technical Specifications

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Salient Features

Technical Specification

- ✓ Voluntary guidance to assist Governments & utilities in developing and emerging economies that are considering a procurement of liquid immersed distribution transformers.

Balance between General & Specific Requirement

- ✓ Includes introductory main part and two annexes providing specifications (Annexes B and C) as per the U4E model regulation.
- ✓ Purchasers can adopt, either as they are or to use as a baseline to adjust to their own unique specifications.

User Flexibility

- ✓ Although the sample technical specifications to use, also provides additional comments and suggestions to each clause of the annexed technical specifications
- ✓ The words/terms/figures in grey indicate that the purchaser should pay attention to suit their system requirements.

Promotes Life Cycle Cost based Purchases

- ✓ Procurement policies set a minimum energy performance (max. losses) of the transformer and include Total Cost of Ownership (TCO) based evaluation of the bids.

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2. India Case Studies: Transforming the Transformers Active Repair Way

Objectives
Legacy Distribution Transformers Improvement

1

Loss Reduction

Total Technical Losses reduction

2

Reliability Improvement

Reducing DT Failure rates

3

kVA Capacity Enhancement

Increasing kVA capacity of DTs to allow higher % loading

Intensity of Problem: High DT Failure rates, huge spent on R&M, and High DT Technical Losses

Failure rate is the most observed KPI for DTs. DT Technical losses mostly remain undiscovered.

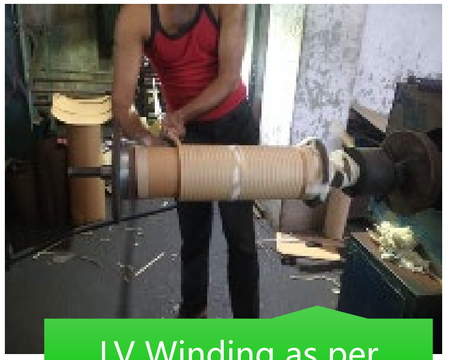
	All India statistics
Total DT stock	~12.5 million
Total DT MVA capacity	~2,20,000 MVA
Avg. DT Failure rate	~12-15% (6-8 lakhs DTs fail yearly)
Repair and Maintenance costs spent on DTs repair	~3,000 INR crores/ year
Avg. Total Technical losses in DTs	~3%
Avg. AT&C losses	24%

Recent trend is to sweat key assets by the utility

Methodology:
Legacy Distribution Transformers Improvement

Received DT at MTRU

Pre-repair testing (open circuit and short circuit test) at MTRU with MPPKVVCL representatives



LV Winding as per design at MTRU

HV Winding as per design at MTRU

Assembled DT ready to be moved for oven drying

Oven dried DT placed in tank as final assembly

Post Repair testing with MPPKVVCL representatives

Final Active Repaired DT was sent to ERDA for validation of results

DT to be connected in the network

Monitor performance of the DT

Active Repair Example – Solution & Results

100 kVA DT was found to be approx. 86kVA based on the pre-repair test results and radiator fins calculation

Key Design Parameters	Unit	Utility Specs	Baseline Pre-repair (at MTRU)	% Deviation from Specs	Actual Post-repair (at ERDA)	% Change from baseline
Capacity	kVA	100	86*		109**	+20%
Year of Manufacturing			2013			
LV Winding Material			DPC Al		DPC Copper	
# of LV Turns	#		76		76	0%
HV Winding Material			DPC Al		DPC Copper	
# of HV Turns	#		3,344		3,344	0%
No Load Loss	Watts	260	258	-0.7%	295	+15% ***
Full Load Loss	Watts	1,760	2,358	+34%	1168	-50%
Impedance	%	4.05 – 4.95	3.84		4.21	
Total Winding Weight	Kg		46.62		192.36	

**Based on pre-repair test results and radiator fins calculation as mentioned in slide 12*
***kVA enhancement inferred and estimated from ERDA results*
****The allowed tolerance for loss level as per TS-1116 for repaired transformer are: No-load loss is 15% ; Full load loss is 15%; Total loss is 10%. No Load loss could have been reduced by increasing no. of turns with trade-off of slight higher (still reduced) Full Load loss. Total Loss optimization was done.*

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Cost Benefit Analysis

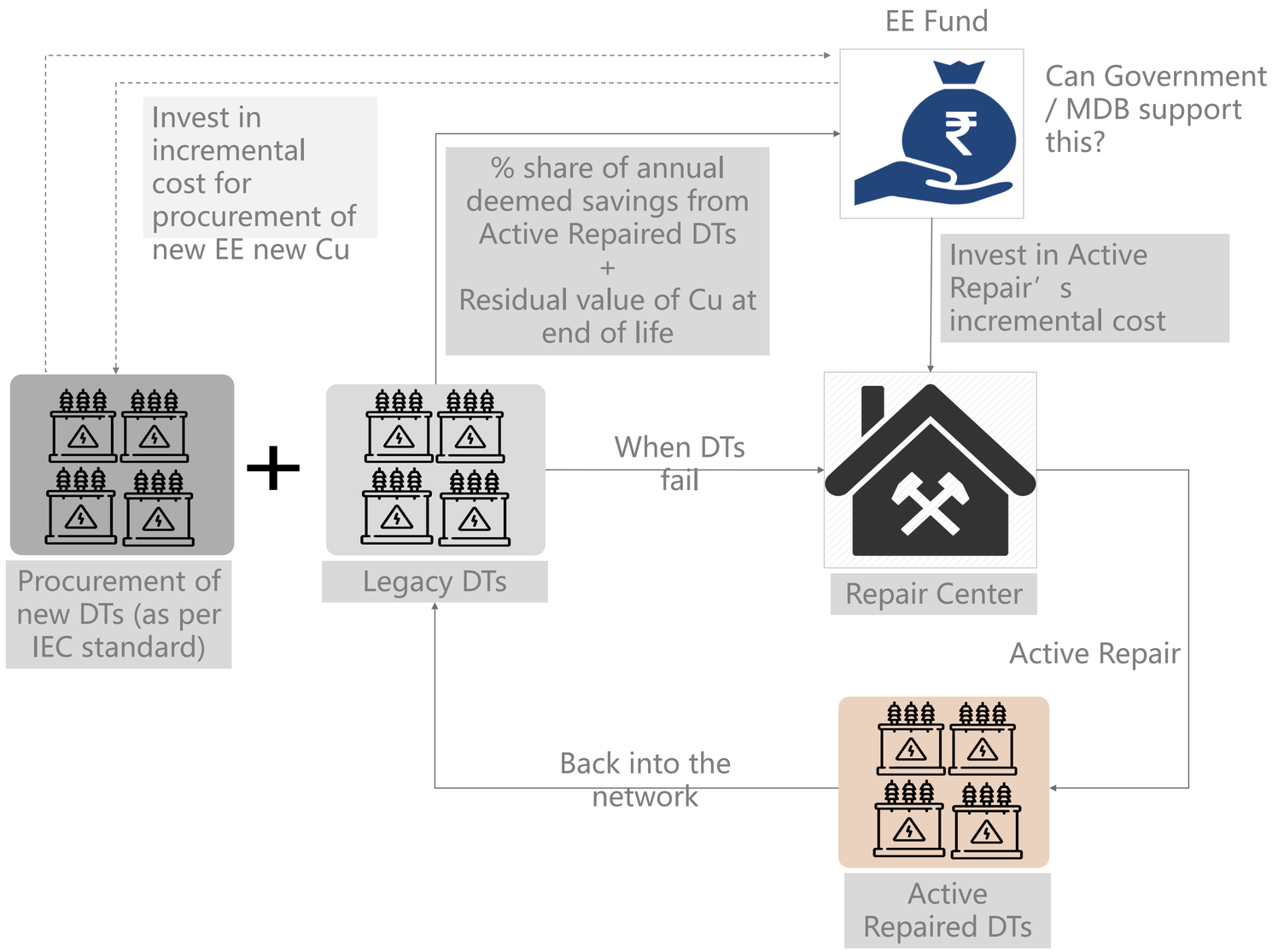
Active Repair provides good cost economic option to Discom to upgrade legacy DTs asset with performance improvement objective.

Cost Benefit Analysis	
Total Units Saved (kWh/year)	4,779
Avg. Cost of Supply (Rs./kWh)	6.25
Total Money Saved (INR/year)	29,871
Total Cost for Active Repair (INR)	98,131
Total Cost for Conventional Repair (INR)	11,342
Incremental Cost (INR)	86,789
Simple Payback Period including financing charges (years)	1.66

Cost Benefit Analysis with EoL Salvage Value	
Total Units Saved (kWh/year)	4,779
Avg. Cost of Supply (Rs./kWh)	6.25 (as per regulator' s Tariff order of 2017-18)
Total Money Saved (INR/year)	29,871
Total Cost for Active Repair (INR)	98,131
Total Cost for Conventional Repair (INR)	11,342
Incremental Cost (INR)	86,789
Cu Salvage Value (INR)	89,006
Simple Payback Period including financing charges (years)	2

! INR = 1 MZN

Potential Business Model - EDM



Issues that need to be addressed:

- Standardization of Active Repair solution
- Skill set
- Material Procurement
- Inhouse repair vs outsource
- Test capability
- Design support

Contact

TRANSFORMING MARKETS TO ENERGY-EFFICIENT PRODUCTS

Thank you

PHONE

EMAIL

soledad.garcia@un.org
mayur.karmarkar@copperalliance.asia

WEBSITE

united4efficiency.org