

International review of Standards and Labelling programs for Distribution Transformers

Virginie Letschert

Lawrence Berkeley National Laboratory

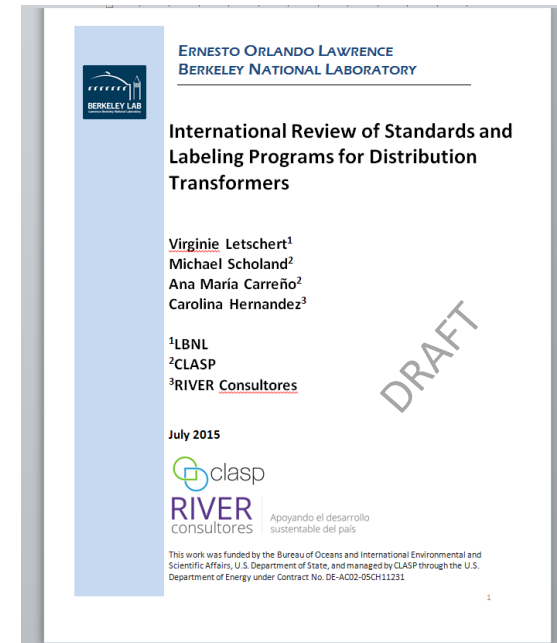
Study Summary

◆ International Experience

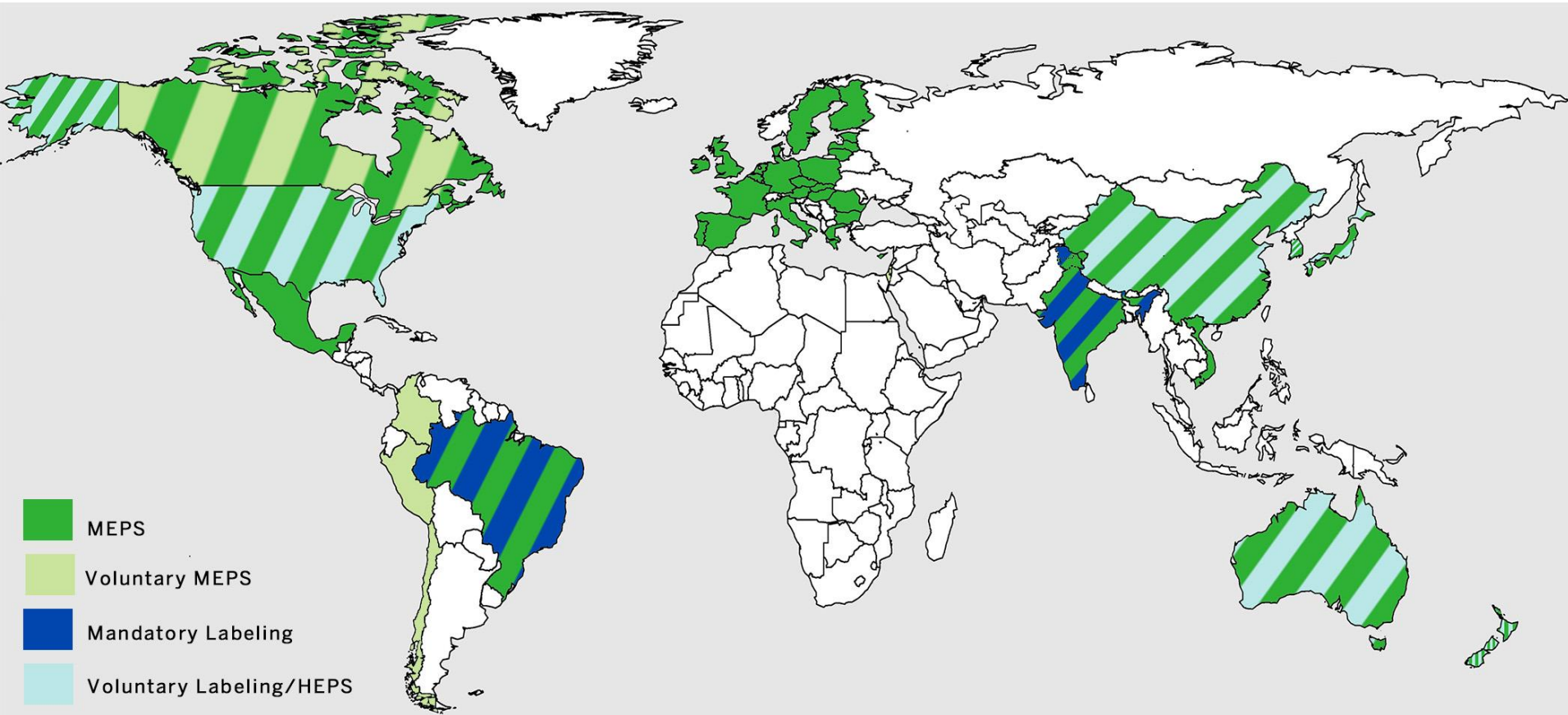
- ❑ International review is part of the steps required to set a MEPS in Chile
- ❑ The review seeks to answer:
 - What type of programs are there?
 - What are the technical aspects of these programs (scope, definition of requirements, test method)?
 - How do these programs compare?
 - How this information will be used in our project?

◆ Results of the Study:

- ❑ 14 countries with programs, 23 types of different programs and 2 reference testing methods



I-Types of MEPS and labelling programs



Mandatory labelling programs

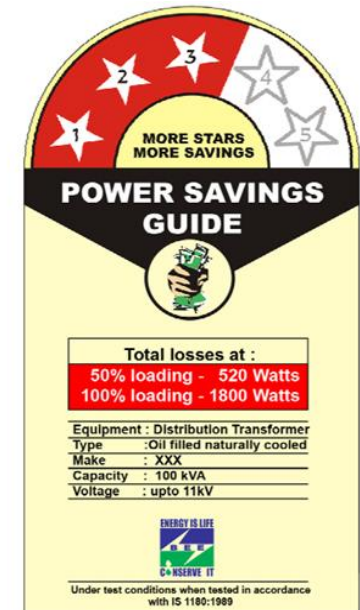
These labels provide information, with a scale or a set of similar classification, which allows the user to compare the performance of power among different products.

◆ Programs in Brazil, India

◆ Information about:

- ❑ Make, model, type of TD
- ❑ Capacity (kVA)
- ❑ Class of tension (kV)
- ❑ Lost without load, load, 50% load (India)

Energia (Elétrica)		TRANSFORMADORES DE DISTRIBUIÇÃO EM LÍQUIDO ISOLANTE	
Fornecedor		PERDAS MÁXIMAS (tap nominal)	
Modelo		- Vazio (W)	00000
Tipo		- Totais (W)	00000
Potência (kVA)		- Relação Transformação	00000
Classe de Tensão (kV)		PERDAS MÁXIMAS (tap crítico)	
 		- Vazio (W)	00000
		- Totais (W)	00000
<small>INMETRO</small>		- Relação Transformação	00000
<small>INMETRO</small>		NBI (kV)	00000



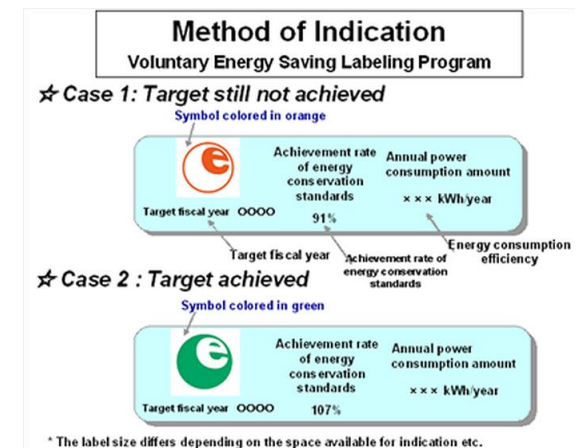
Energía		ENERGÍA ORIGIN
Fabricante		Automática
Modelo		
		
CONSUMO REACTIVO (kVArh/mes)	26,5	
Temperatura de ambiente: 20°C		
Volumen de almacenamiento refrigerado (L)	200	
Volumen de almacenamiento congelado (L)	100	
Temperatura de compartimento congelador (°C)	-18	

Note: in Chile, there is such a labelling program for a variety of industrial motors and household products (1-10HP)

Programs of voluntary labelling (label of endorsement)

These labels identify products that stand for the performance of a defined requirement of efficiency (higher than the baseline)

- ◆ Programs in the US, Japan, China
- ◆ Energy Star – in development



Conclusion: Labelling programs inform the user but do not guarantee the adoption of more efficient technology. In the case of TD, international experience shows that these programs have a more significant impact in combination with other programs. They have the advantage of allowing definition of requirements for procurements made by utilities.

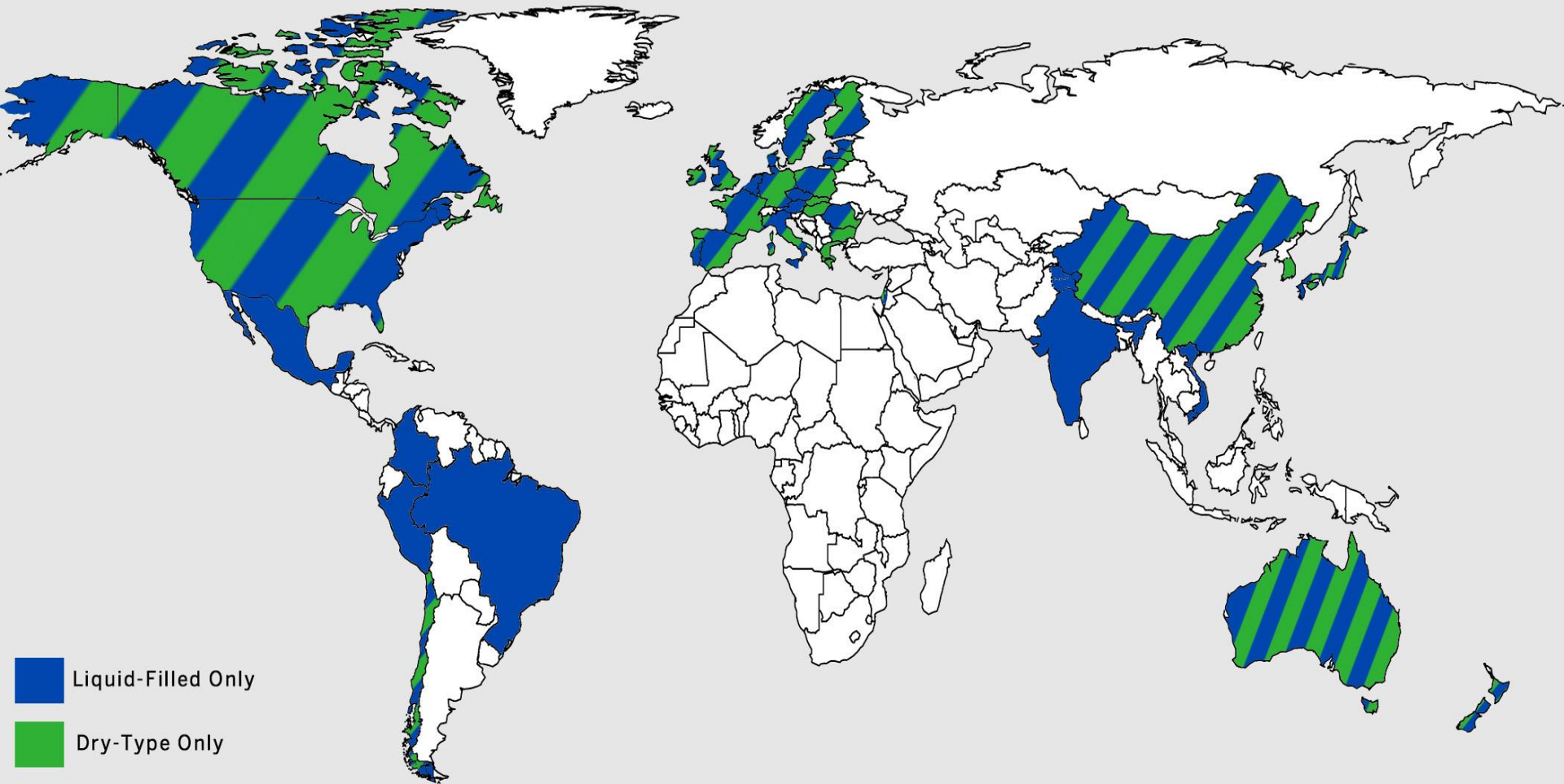
MEPS Program

A MEPS or energy efficiency standard will remove a part of the market that does not meet a minimum level of energy efficiency / performance

- ◆ Most common programs: found in (almost) every country review - (compulsory or voluntary)
- ◆ When required, type of policy the more powerful to ensure the transformation of the market

The project will investigate a combination of a MEPS with a complementary program (push and pull mechanism)

2-Scope of programs of MEPS and labelling

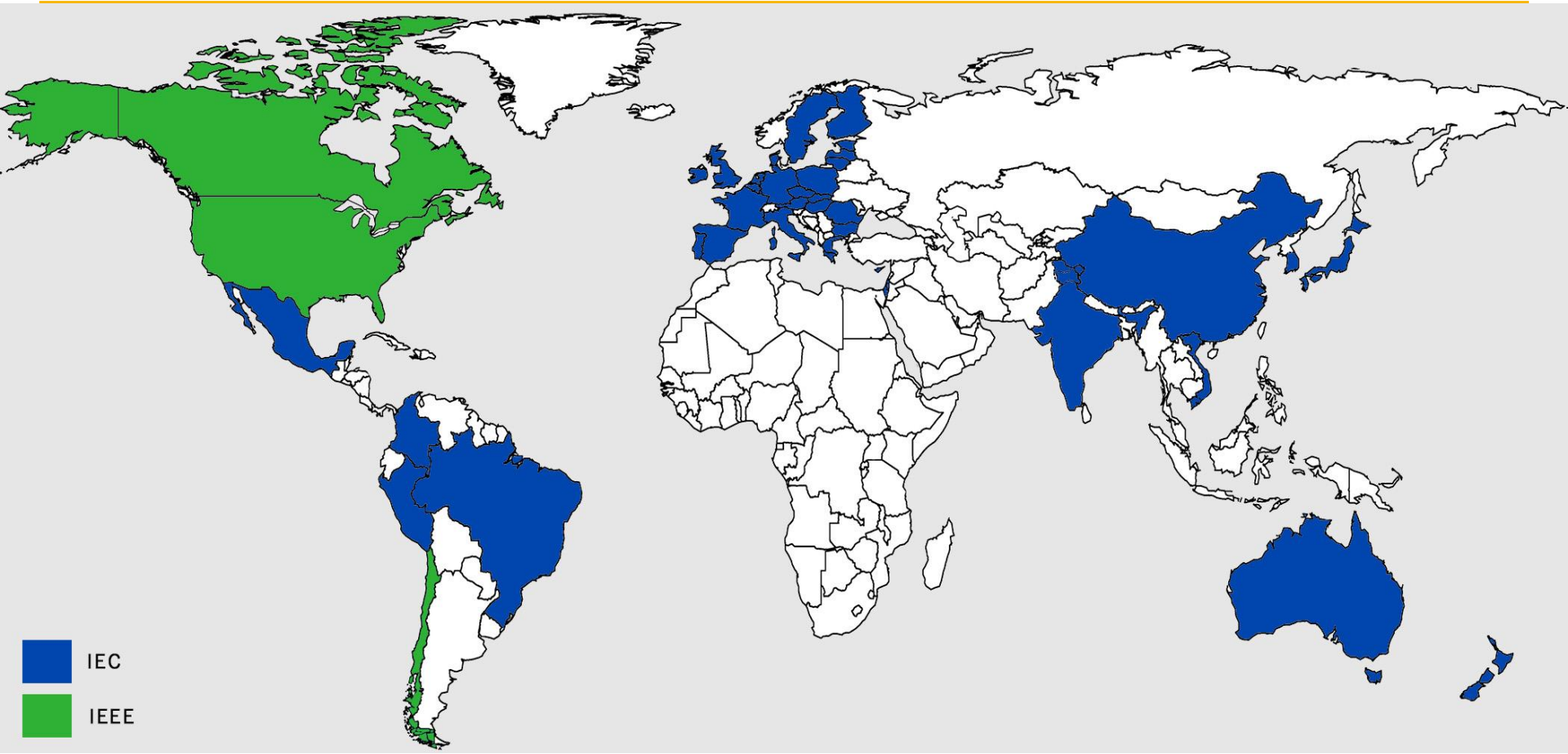


3-Comparison of test methods

◆ 2 Families of test standards:

- ❑ IEC: 19 Parties to the standard 60076. The review focuses on:
 - Part 1: Generalities
 - Part 2: Immersed in fluid for transformers temperature rise
- ❑ IEEE: 90 standards and guides in the family C57.12. The review focuses on:
 - C57.12.00: General requirements for distribution, power, and regulating transformers, liquid
 - C57.12.80: Standard terminology for distribution and power transformers
 - C57.12.90: Code of trial for distribution, power, and regulating transformers, liquid

Test Methods



Aspects

- ◆ Testing in general condition requirements
- ◆ Measurement of no-load losses(PSC)
- ◆ Measurement of load losses(PCC)
- ◆ The efficiency calculation

2 examples to illustrate the study

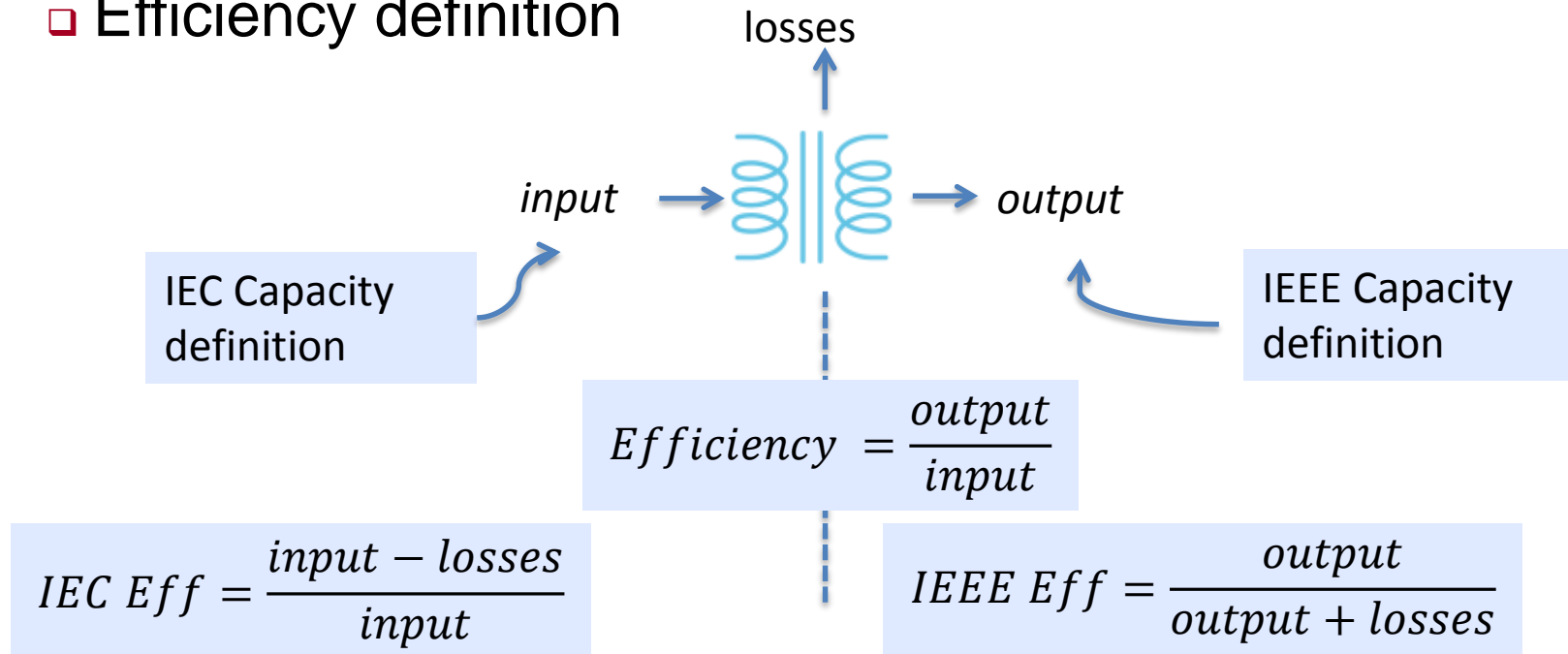


Loss Measurement

- ◆ Comparison of:
 - Reference temperature
 - Temperature correction formula
 - Measurement tolerances
 - Test current
 - Method of measuring resistance
 - Winding temperature
- ◆ Example: Reference temperatures (difference the more important and difficult to reconcile)
- ◆ Without load: IEC: 75C - IEEE: 20C
 - With load: IEC: 75C - IEEE: 85C

Efficiency Calculation

- ◆ Comparison of:
 - Capacity definition
 - Efficiency definition



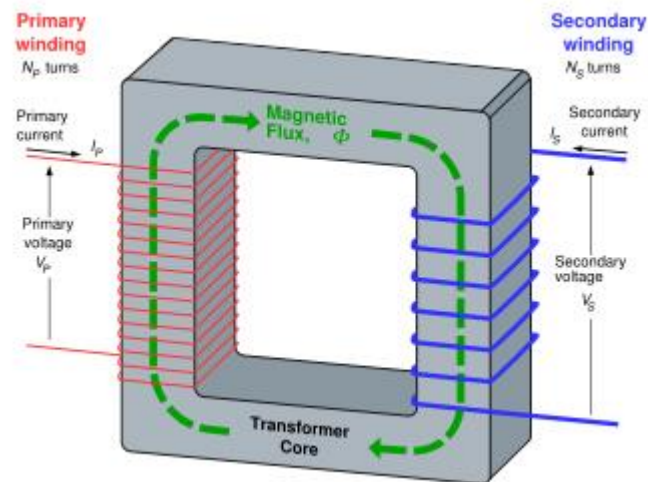
Same result in the calculation of efficiency for a given transformer, only need to convert the capacity when it refers to a transformer IEC or IEEE

Process of “Dual Logo” IEC-IEEE

- ◆ IEC and IEEE have acknowledged the need for harmonization, as well as the benefits and challenges of a harmonized standard.
- ◆ Process of "double logo" working groups to establish common standards that carry the logo of the standard IEC / IEEE
- ◆ It already exists for the following standards of power transformers:
 - ◆ IEC 60076-21 Ed. 1 (2011-12) (IEEE Std C57.15™-2009 Power Transformers - Part 21: Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators
 - IEC 62032 Ed.1 (2005-03) (IEEE C57.135™-2001): Guide for the Application, Specification and Testing of Phase-Shifting Transformer

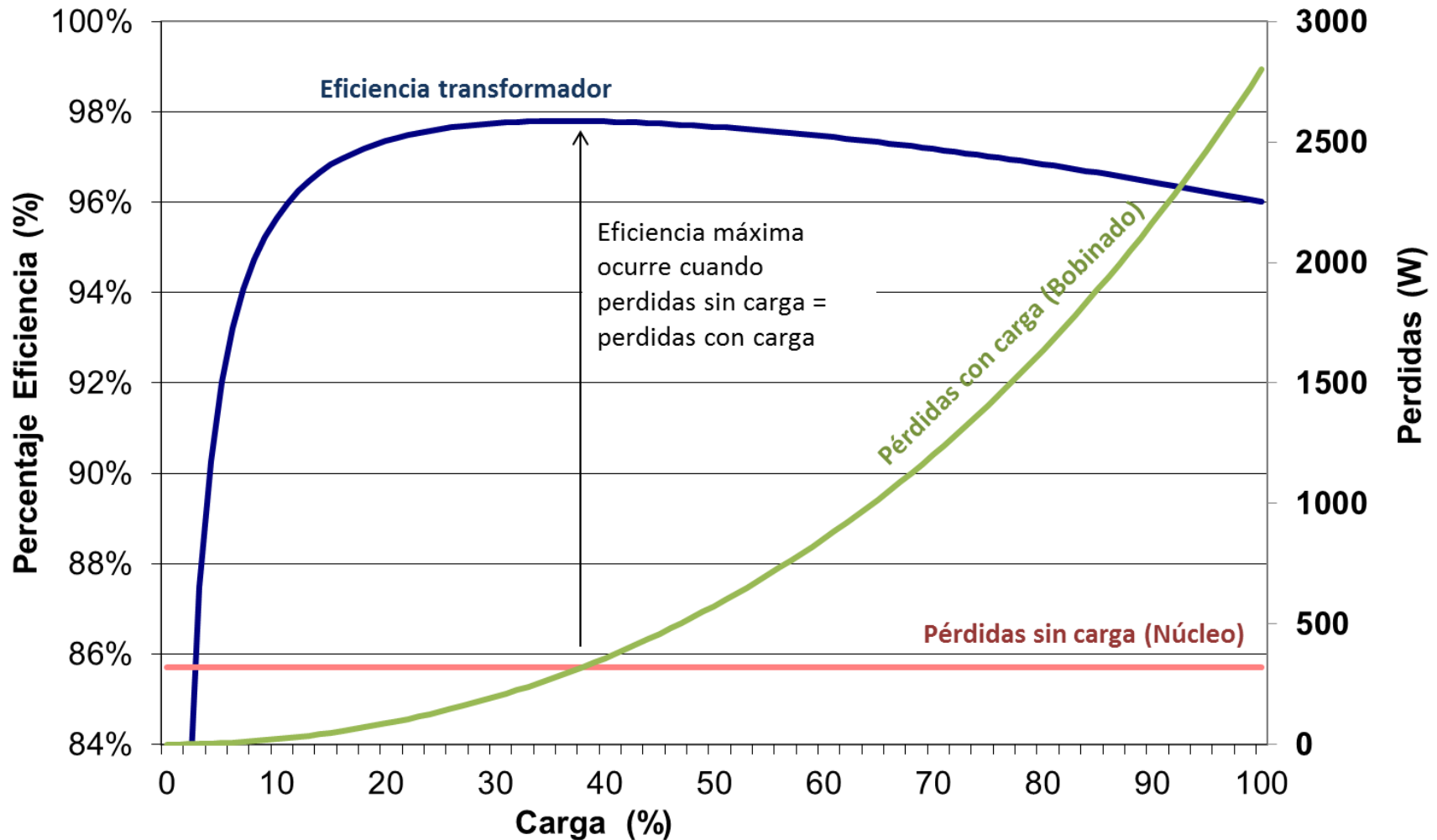
4-Performance metrics

- ◆ Transformer performance metric is a key element of the definition of EE program
- ◆ The metric is closely related to the design of the TD



- ◆ Performance metrics can be applied to the design of the core, winding, or to the sum of the two.

Evolution of efficiency/loss with load Factor



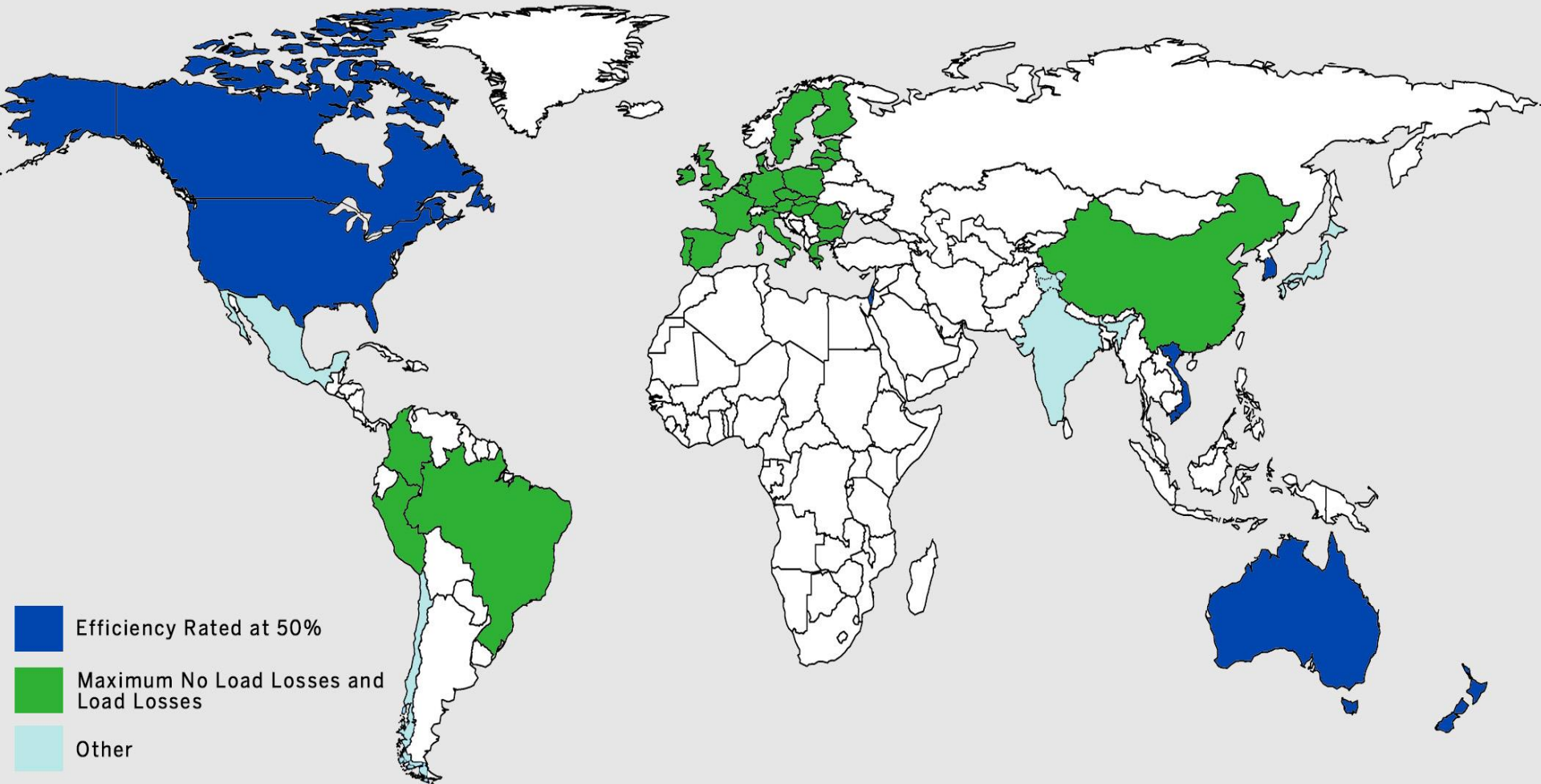
Fuente: SEAD

Performance Metrics

- ◆ **Maximum no-load/load losses:** defines 2 limitations in each design (one in the core, one in the winding)
- ◆ **Maximum combined losses:** defines a limitation unique to the sum of no-load losses and losses of load in a specified load point.
- ◆ **Minimum efficiency:** represents the ratio of the output / input.
% efficiency must be declared at a specified load point
(50% in most cases) *
- ◆ **Peak Efficiency Index (PEI):** maximum efficiency of a given transformer design, regardless of a specified load point.

*Energy Star is developing a series for minimum efficiency of different load factors – still in discussion with the interested parties.

Performance Metrics

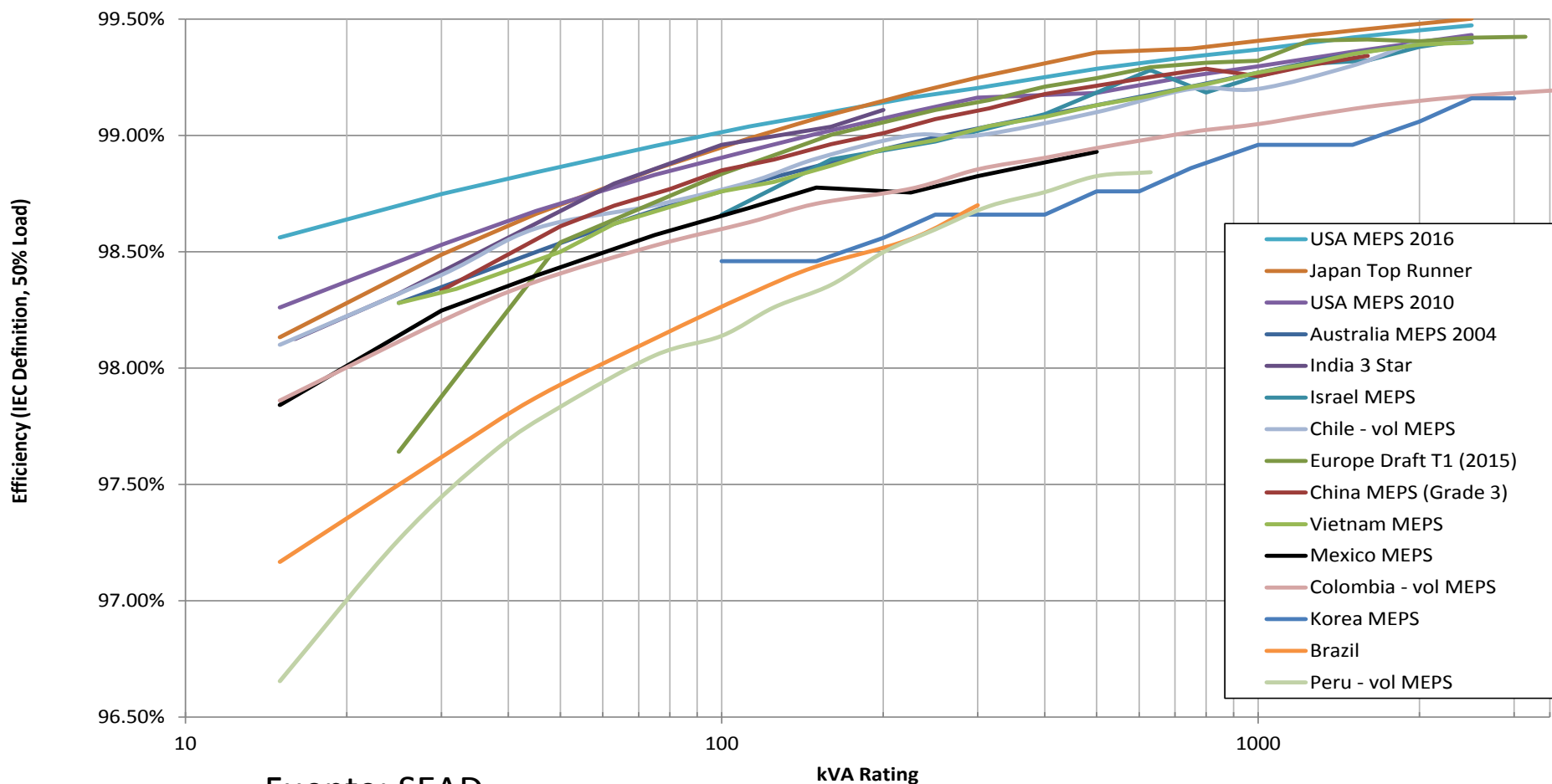


Summary the advantages and disadvantages

Performance Metrics	+	-
Load Losses/ no load losses	<ul style="list-style-type: none"> - It does not require the specification of a load point - Commonly used in procurement practices 	-Restricts technological flexibility / design
Total maximum loss / percentage efficiency	<ul style="list-style-type: none"> - Combining NLL and LL in a metric that provides maximum technological flexibility / design - It allows designs with optimized cost 	- It requires a specific load point
Peak Efficiency Index (PEI)	-It does not require the specification of a load point in the regulation	- It has not been used in regulation of transformers (power transformers only)

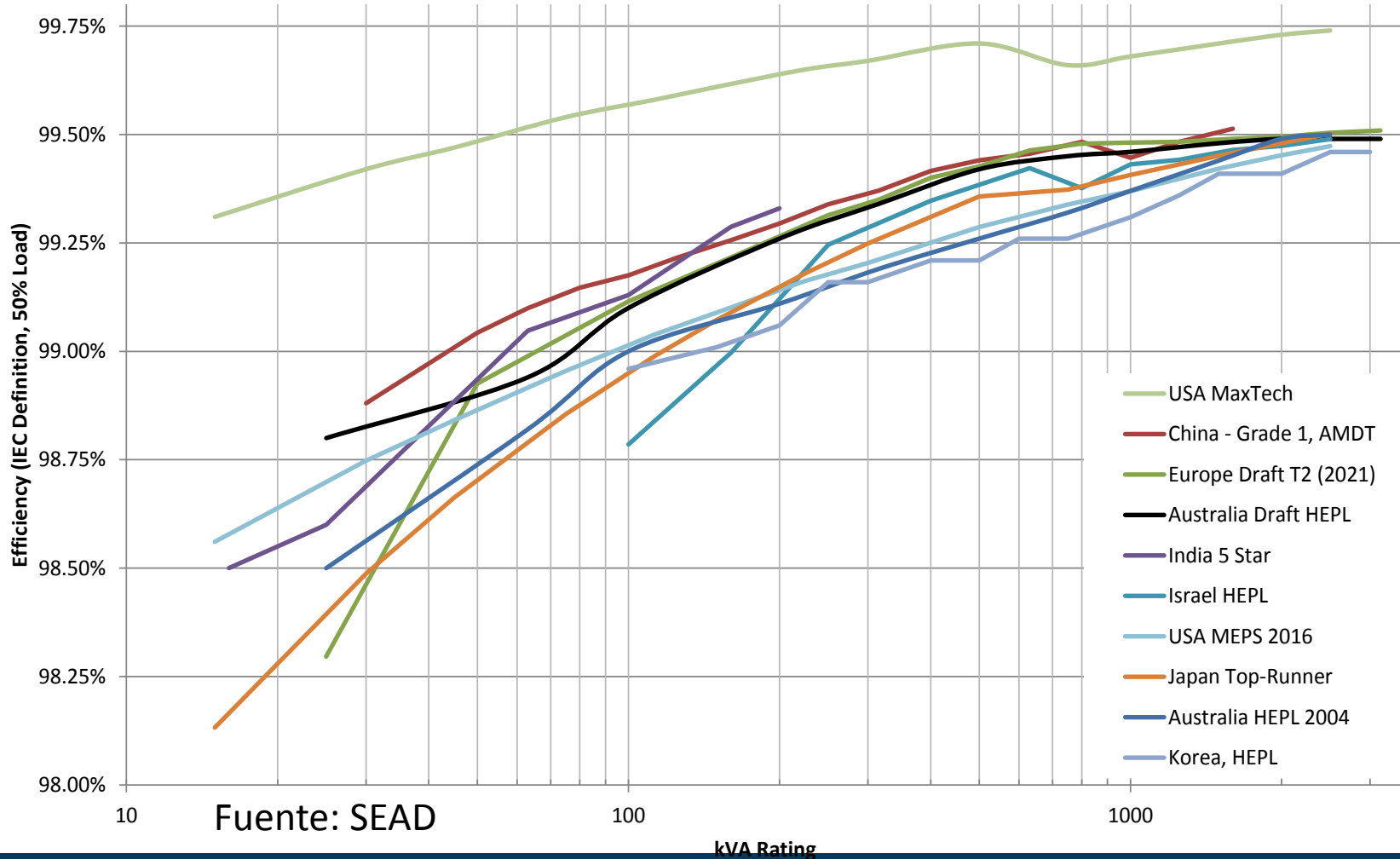
5-Comparison of Programs levels for MEPS and labelling

Requirements of MEPS for distribution transformers 3 - phase liquid type



Comparison of Program levels of MEPS and labelling - high efficiency

High efficiency requirements for TD 3 - phase liquid type



Next Steps

- ◆ The LBNL report presents the information found in the review of international programs
- ◆ In addition, the Ministry of Energy will consider:
 - Practices in Chile regarding test methods and metrics of performance (survey RIVER)
 - Participation in the market of different types of transformers
 - Comments from participants on:
 - Scope
 - Test Methods
 - Performance Metrics