Technical Specifications of Energy Efficient Appliances

Department of Renewable Energy
Ministry of Economic Affairs
Royal Government of Bhutan

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List of Abbreviations

AC	Air Conditioner
ADB	Asian Development Bank
ATF	Aviation Turbine Fuel
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BPC	Bhutan Power Corporation Ltd.
CAGR	Compounded Annual Growth Rate
CEC	Comparative Energy Consumption
CRI	Colour Rendering Index
CFL	Compact Fluorescent Lamp
CRT	Cathode Ray Tube
DC	Direct Current
DEDE	Department of Alternative Energy Development and Efficiency
DSM	Demand Side Management
EE	Energy Efficiency
EER	Energy Efficiency Ratio
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office
ES&L	Energy Standard and Labelling
FEEED	Framework for Energy Efficiency Economic Development
FTL	Fluorescent Tube Light

GHG	Green House Gas
HEPS	High Energy Performance standards
HV	High Voltage
IEC	International Electro-technical Commission
IS	Indian Standards
IT	Information Technology
JICA	Japan International Cooperation Agency
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
LV	Low Voltage
MEPS	Minimum Energy Performance standards
MOE	Margin of Error
MV	Low Voltage
RED	Rural Electrification Department
RGoB	Royal Government of Bhutan
S&L	Standards and Labelling
TIS	Thai Industrial Standards
TISI	Thai Industrial Standards Institute
TV	Television
UV	Ultraviolet

List of Units

C	Centigrade
Hr	Hour
INR	Indian National Rupee
kCal	kilocalorie
kg	kilogram
kgK	Kilogram Kelvin
kJ	kilojoule
kTOE	Kilotonnes of oil equivalent
kW	kilowatt
kWh	kilo Watt hour
L	litre
m	meter
m2,sqm	Square meter
m3,cum	cubic meter
MW	Mega Watt
Nu	Bhutanese Ngultrum
rpm	Rotations per minute
TCO2	Tons of CO2
TOE	Tonnes of Oil Equivalent
TR	Tons of Refrigeration
USD	United States Dollar
W	Watt
EER	Energy Efficiency Ratio

1. Introduction and Definitions in the context of Standards and Labelling

At present, Bhutan does not have a Standard and Labeling programme in place but allows procurement of electrical goods from the different countries, which have a certain energy efficiency level. To ensure procurement of energy efficient appliance, the country looks forward to adopt existing standards of the importing countries and develop own standards for those appliances for which the importing country does not have a standard. This document is intended to serve the purpose of a reference material to help the Government of Bhutan, retailers, importers and other users to:

- Understand the various types of standards and labels that are being used across the world for various electrical appliances and equipment;
- What standards classify as energy efficient?
- How to read the labels on the appliance from the exporting country?
- What the different kinds of labels signify?
- What are the parameters for compliance?

The document specifically caters to those appliances and equipment which have significant importance to the people in Bhutan. Thus, the user of this reference document can find the detailed technical specifications of the appliances that need to be met. The users would find a set of compliances set forth in this document which they might adhere to in case of procurement of the goods. However, compliance with the requirements set forth in this document does not, in itself, guarantee an authorization but acts as a ready reference. Finalization of the compliances rests in the purview of the government and the institutions who may decide on the standards which may be allowed for import of the goods.

The following list or terms defines the scope of this report, which should enable the user to comprehend the report to its best purpose.

- **'Appliances and Equipment'** is defined as the institutional and home appliances which are electrical/mechanical machines which accomplish some household functions, such as cooking, washing or cleaning. Major appliances comprise appliances and equipment which includes: air conditioners, refrigerators, water heaters, washing machines, motors, transformers, scanners, copier machines and microwave ovens. Small household appliances refer to electrical machines which are easily carried and installed such as: laptops, tube-lights, bulbs, television, fans and small heaters such as space heaters, kerosene heaters, and fan heaters. Yet another category is used in the kitchen, including: juicers, electric mixers, etc. Equipment includes electric motors and transformers.

- **'Energy audit'** means verification, monitoring and analysis of machinery, appliances and the processes of utilization of energy entity and determination of its efficiency.

- **'Energy efficiency'** is a way of managing and restraining the growth in energy consumption. An appliance or equipment is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input.

- **'Energy conservation'**refers to reducing energy consumption through using less of an energy service through reducing wastage and over-use for the same purpose.

- **'Energy efficiency standards'** deal with measures and regulations required for prescribing the energy performance of energy-consuming products. The proposed implementation of

energy efficiency Standards and Labelling (S&L) for appliances is an initiative to restrict supply of inefficient appliances to the consumers.

- **'Minimum Energy Performance Standard'** (MEPS) specify the maximum permissible energy consumption limit for a given appliance in performing a specific task. Appliance with higher efficiency will have lower MEPS as it would consume lesser amount of energy.

- **'Energy efficiency labels'** are attached to energy-consuming appliances or devices to showcase their energy performance to potential users. Generally, energy efficiency labels are divided into Endorsement label and Comparative label (including categorical, continuous scale and Information-only labels)

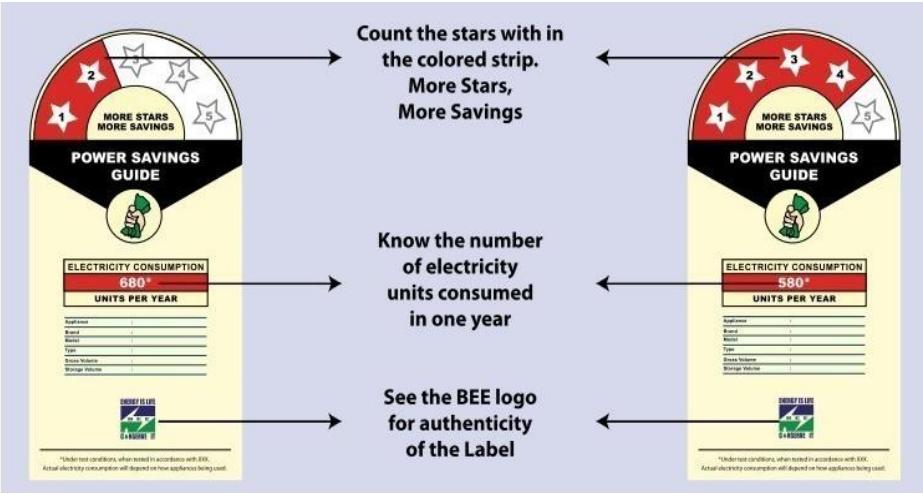
- **'Comparative labels'** allow consumers to form a judgment about the energy efficiency (or energy consumption) and relative ranking across products that carry a label. The comparative labelling programs for appliances and equipment in OECD countries are primarily mandatory; however some comparative programs in other countries are voluntary. Endorsement and comparative labels can co-exist, and do so in many countries. The most commonly used comparative labels use a scale with defined efficiency categories or thresholds.

- **'Endorsement labels'** indicate that products belong to the "most energy efficient" class of products or meet a predetermined standard or eligibility criteria. Products generally display a logo or mark which identifies they have met the standard or product class and endorsement labels generally contains little or no comparative energy efficiency information. This type of label merely informs the consumer that the product meets a required standard or benchmark. Endorsement labelling programs are mostly voluntary in nature.

2. Appliances' Specifications and Rating Techniques

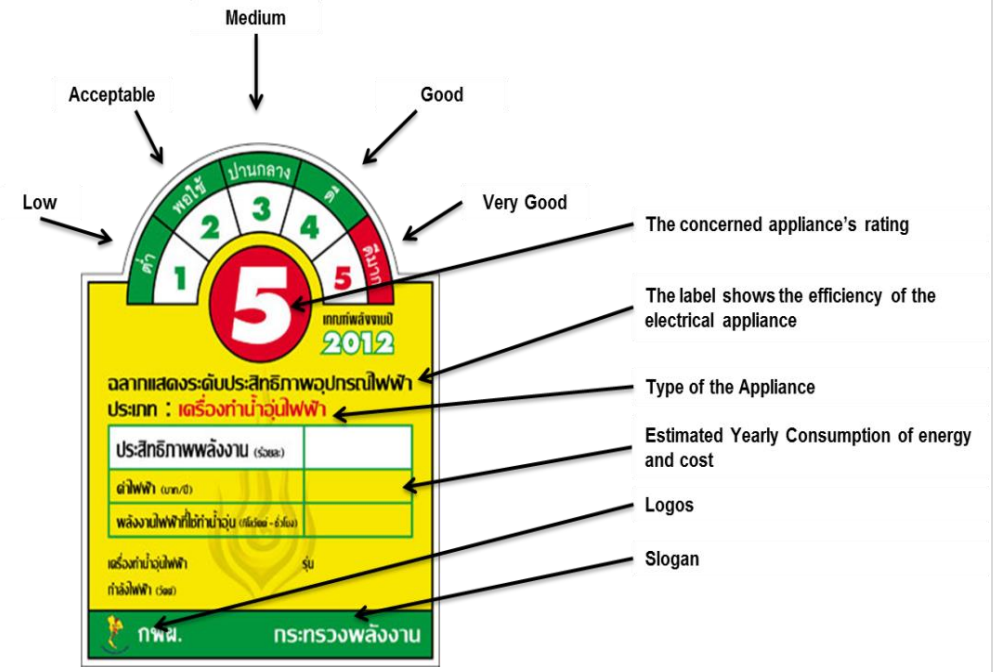
<table>
<tr><th>APPLIANCE</th><th>SPECIFICATIONS</th></tr>
<tr><td>Washing Machine</td><td>
<table>
<tr><td>Type</td><td>Fully automatic – Top Loading</td></tr>
<tr><td>Capacity</td><td>5.5 to 7 kg</td></tr>
<tr><td>Usual Dimension
(L X W X H)</td><td>598 X 506 X 875 mm</td></tr>
<tr><td>Power Consumption</td><td>350 – 450 Watt hour</td></tr>
<tr><td>Rating Calculator= total energy consumption per kilogram of clothes in the machine being washed</td><td>
<table>
<tr><th colspan="3">Energy Consumption (kWh/kg)
Fully Automatic</th></tr>
<tr><th>MAX.</th><th>MIN.</th><th>Star Band</th></tr>
<tr><td>0.0186 ≥</td><td>≥ 0.0169</td><td>1 Star</td></tr>
<tr><td>0.0169 ></td><td>≥ 0.0154</td><td>2 Star</td></tr>
<tr><td>0.0154 ></td><td>≥ 0.0140</td><td>3 Star</td></tr>
<tr><td>0.0140 ></td><td>≥ 0.0126</td><td>4 Star</td></tr>
<tr><td colspan="2">< 0.0126</td><td>5 Star</td></tr>
</table>
Illustration: As per Indian standards
</td></tr>
<tr><td colspan="2">

Total energy consumption per kilogram of clothes in the machine being washed (kWh/kg) is the parameter mentioned in the labels of the appliance.
A washing machine's energy-efficiency rating is calculated by measuring kilowatt hours (kWh) used annually by the machine, based on its performance on full and partial cloth load. Given a cloth load at a particular temperature, the most efficient washing machineis one which uses the least amount of electrical energy in these circumstances.
One should compare the energy consumption mentioned in the label given the size/ capacity and the built type of the machine one wishes to buy or procure.

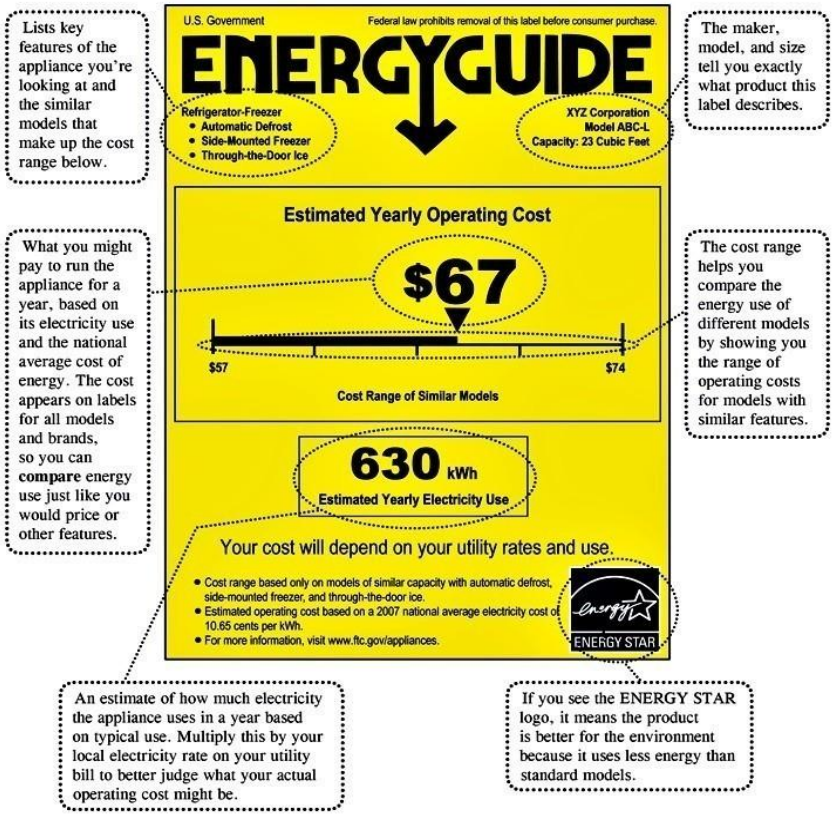
Indian Label:


</td></tr>
</table>
</td></tr>
</table>

APPLIANCE	SPECIFICATIONS
	Thailand Label:



United States label:



APPLIANCE	SPECIFICATIONS
Television	

Type	Generic specification for colour picture tube with electrostatic focusing and electromagnetic deflection for colour television receivers
Power Consumption	70 – 120 Watt-hour

Rating Calculator– Power consumption given the screen size (area, length)

Screen Size (cm)	Screen Area (sq cm)	Max Annual Power Consumption for 1 Star (kWh/Year)	Max Annual Power Consumption for 2 Star (kWh/Year)	Max Annual Power Consumption for 3 Star (kWh/Year)	Max Annual Power Consumption for 4 Star (kWh/Year)	Max Annual Power Consumption for 5 Star (kWh/Year)
		P = (0.964 x A) + 4.38	P = (0.876 x A) +4.38	P = (0.788 x A) + 4.38	P = (0.701 x A) + 4.38	P = (0.613 x A) + 4.38
50.8	434.1	169	154	139	124	109
66.0	733.8	283	257	232	207	181
81.3	1111.5	426	388	349	311	273
94.0	1485.9	568	517	465	414	363
106.7	1914.7	731	665	598	533	466
116.8	2296.7	876	796	717	638	559
127.0	2713.2	1034	940	846	753	659
139.7	3283.2	1250	1137	1023	910	797

Illustration: As per Indian standards

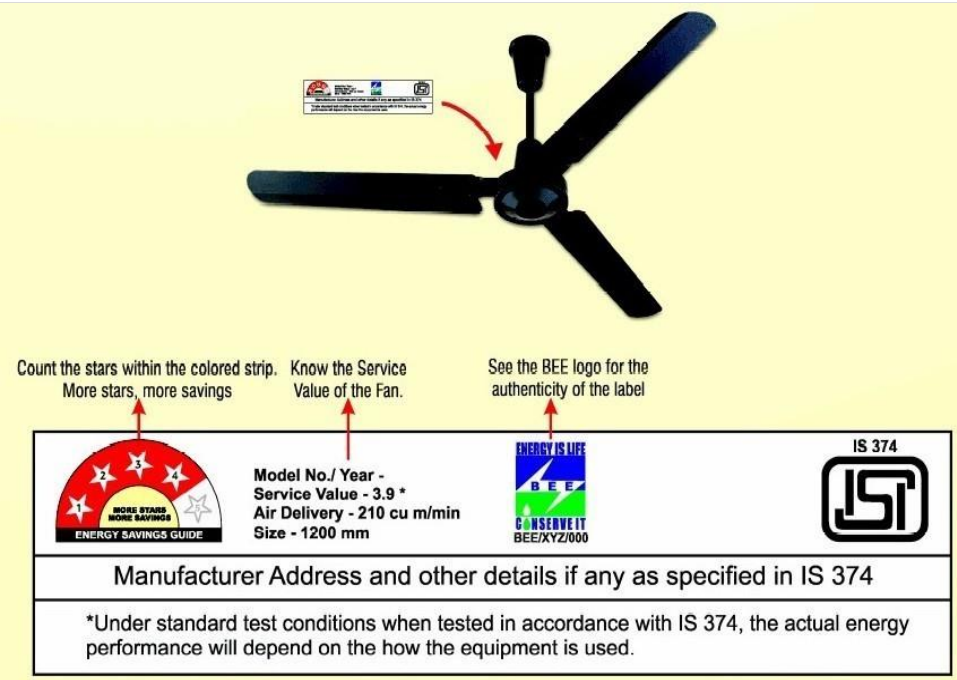
'A' is the viewable screen area of the product, found by multiplying the display width by the display height.

- Total energy consumption per screen area (kWh) is the parameter mentioned in the labels of the appliance.
- Given the screen size/area, a television consumes electricity varying upon the status of the appliances, whether it is on active or sleep mode. Particularly, televisions with LED screens are more energy efficient given the screen area.
- One should compare the energy consumption mentioned in the label given the size of the machine one wishes to buy.

Indian Label:

<table>
<tr><th>APPLIANCE</th><th>SPECIFICATIONS</th></tr>
<tr><td>Fan</td><td>
<table>
<tr><td>Type</td><td>Ceiling fans</td></tr>
<tr><td>Power consumption</td><td>70 – 100 Watt-hour +/- 10%</td></tr>
<tr><td>Minimum Sweep range</td><td>1200mm.</td></tr>
<tr><td>Service value</td><td>Air velocity per minute for every watt-hour of energy consumed (metre^3/minute/watt)</td></tr>
<tr><td>Star Rating Plan: Service Value</td><td>
<table>
<tr><th>Star Rating</th><th>Service Value for Ceiling Fans*</th></tr>
<tr><td>1 Star</td><td>≥ 3.2 to < 3.4</td></tr>
<tr><td>2 Star</td><td>≥ 3.4 to < 3.6</td></tr>
<tr><td>3 Star</td><td>≥ 3.6 to < 3.8</td></tr>
<tr><td>4 Star</td><td>≥ 3.8 to < 4.0</td></tr>
<tr><td>5 Star</td><td>≥ 4.0</td></tr>
</table>
Illustration: As per Indian standards
</td></tr>
</table>

Service Value (cum/min/W)is the parameter mentioned in the labels of the appliance.
Service value is the air velocity per minute for every watt-hour of energy consumed (metre^3/minute/watt)
For a given air velocity and area coverage, the most efficient fan consumes the least amount of energy

Indian Label:


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</table>

APPLIANCE	SPECIFICATIONS

Geyser

Type	Stationary Storage Type Water Heaters
Capacity	6 to 200 litres
Star rating basis	Standing Losses verses Rated Capacity
Standing Loss	The Standing loss which is the energy consumption of a filled water heater, after steady state conditions have been reached when connected to electrical supply, when no water is drawn for 24 hours.

Rating Calculator

Rated Capacity (Liters)	1 Star	2 Star	3 Star	4 Star	5 Star
	Standing Losses (kwh/24 hour/45°C)				
6	≤ 0.792 & >0.634	≤ 0.634 & >0.554	≤ 0.554 & >0.475	≤ 0.475& >0.396	≤ 0.396
10	≤ 0.990&>0.792	≤ 0.792&>0.693	≤ 0.693&>0.594	≤ 0.594&>0.495	≤ 0.495
15	≤ 1.138&>0.910	≤ 0.910&>0.797	≤ 0.797&>0.683	≤ 0.683&>0.569	≤ 0.569
25	≤ 1.386&>1.109	≤ 1.109&>0.970	≤ 0.970&>0.832	≤ 0.832&>0.693	≤ 0.693
35	≤ 1.584&>1.267	≤ 1.267&>1.109	≤ 1.109&>0.950	≤ 0.950&>0.792	≤ 0.792
50	≤ 1.832&>1.466	≤ 1.466&>1.282	≤ 1.282&>1.099	≤ 1.099&>0.916	≤ 0.916
70	≤ 2.079&>1.663	≤ 1.663&>1.455	≤ 1.455&>1.247	≤ 1.247&>1.040	≤ 1.040
100	≤ 2.376&>1.901	≤ 1.901&>1.663	≤ 1.663&>1.426	≤ 1.426&>1.188	≤ 1.188
140	≤ 2.673&>2.138	≤ 2.138&>1.871	≤ 1.871&>1.604	≤ 1.604&>1.337	≤ 1.337
200	≤ 2.970&>2.376	≤ 2.376&>2.079	≤ 2.079&>1.782	≤ 1.782&>1.485	≤ 1.485

Illustration: As per Indian standards

- Standing Losses (kWh/24hour/45°C difference) is the parameter mentioned in the labels of the appliance.
- So a geyser having the same capacity in litres can be compared in terms of the standing losses

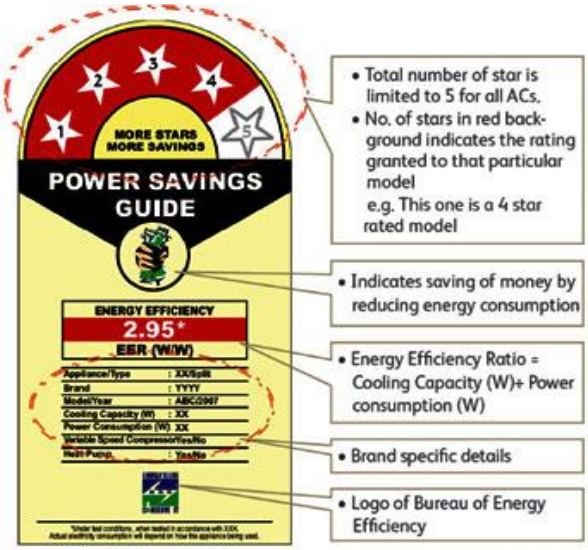
Indian Label:

APPLIANCE	SPECIFICATIONS
	Thailand Label:

Standing losses, efficiency criterias and estimated Yearly Consumption of energy and cost

<table>
<tr><th>APPLIANCE</th><th>SPECIFICATIONS</th></tr>
<tr><td>Air conditioner</td><td>
<table>
<tr><td>Type</td><td>Split Air-conditioners</td></tr>
<tr><td>Power consumption</td><td>2,000 Watt-hour +/- 10%</td></tr>
<tr><td>Capacity</td><td>1 tonne to 2 tonne</td></tr>
<tr><td>Compressor</td><td>Rotary</td></tr>
<tr><td>Energy Efficiency Ratio (EER)</td><td>EER is a measure of how efficiently a cooling system operates when the outdoor temperature is at a specific level. Mathematically,
EER = Capacity/ Power consumed in an hour</td></tr>
<tr><td>Rating Calculator: EER (W/W)</td><td>
<table>
<tr><th></th><th colspan="2">EER (W/W)</th></tr>
<tr><th>Star Rating</th><th>Min</th><th>Max</th></tr>
<tr><td>1 Star *</td><td>2.70</td><td>2.89</td></tr>
<tr><td>2 Star **</td><td>2.90</td><td>3.09</td></tr>
<tr><td>3 Star ***</td><td>3.10</td><td>3.29</td></tr>
<tr><td>4 Star ****</td><td>3.30</td><td>3.49</td></tr>
<tr><td>5 Star *****</td><td>3.50</td><td></td></tr>
</table>
Illustration: As per Indian standards</td></tr>
</table>

Energy Efficiency ratio (EER) is the parameter mentioned in the labels of the appliance. Higher EER, higher is the efficiency.
EER is a measure of how efficiently a cooling system operates when the outdoor temperature is at a specific level.
Mathematically, EER = Cooling Capacity of the AC/ Power consumed in an hour. For example, one would calculate the amount of electricity consumed to cool 1 tonne to 2 tonne of space as specified as the capacity.

Indian Label:


</td></tr>
</table>

APPLIANCE	SPECIFICATIONS

Refrigerators

Type	Frost – free Refrigerator
Power consumption	300 Watt-hour +/- 10%
Gross Volume	180 – 600 litres
Storage Volume	200 – 650 litres

Rating Calculator

$$\text{Star Rating Band (SRB)}_{nf} = k_{nf} * V_{adj\_tot\_nf} + c_{nf}$$

k_{nf} = Constant Multiplier (kWh/Litre/Year)

$V_{adj\_tot\_nf}$ = Total Adjusted Storage Volume for No Frost (Litre)

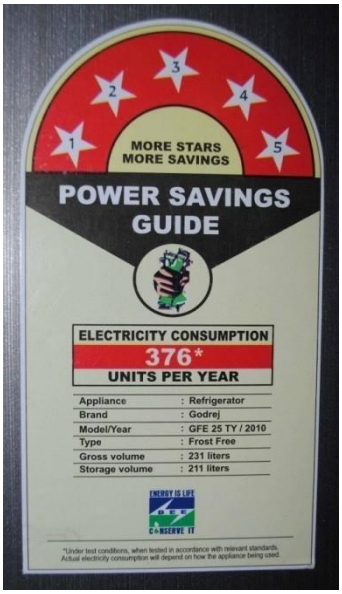
c_{nf} = Constant Fixed Allowance (kWh/Year)

Star rating band	Minimum CEC	Maximum CEC
1 Star *	≥0.4463 * $V_{adj\_tot\_nf}$ +389	0.3570 * $V_{adj\_tot\_nf}$ +311
2 Star * *	≥ 0.3570 * $V_{adj\_tot\_nf}$ +311	0.2856 * $V_{adj\_tot\_nf}$ +249
3 Star * * *	≥ 0.2856 * $V_{adj\_tot\_nf}$ +249	0.2285 * $V_{adj\_tot\_nf}$ +199
4 Star * * * *	≥ 0.2285 * $V_{adj\_tot\_nf}$ +199	0.1828 * $V_{adj\_tot\_nf}$ +159
5 Star * * * * *	≥ 0.1828 * $V_{adj\_tot\_nf}$ +159	

Illustration: As per Indian standards

- Total power consumption is the information mentioned in the labels of the appliance.
- CEC is a measure of the annual expected electricity consumption of the refrigerators. It is a parameter indicating the total power consumption.

Indian Label:



<table>
<tr><th>APPLIANCE</th><th>SPECIFICATIONS</th></tr>
<tr><td>Room heater</td><td>
<table>
<tr><td>Type</td><td>Electric Storage room heaters: Fan Forced Hot Air Circulation</td></tr>
<tr><td>Power consumption</td><td>1,200 – 2,000 Watt-hour +/- 10%</td></tr>
<tr><td rowspan="2">Efficiency Measurement factors</td><td>1. Heat retention/ time/space (or room size)</td></tr>
<tr><td>2. Power consumed to heat in a given time/ space</td></tr>
<tr><td>Few Important definitions for understanding heater specifications</td><td>► Space heater’ means a device that a) provides heat to a water-based central heating system in order to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room; and b) is equipped with one or more heat generators.

► ‘Seasonal space heating energy efficiency’ is in a key role as a base for labelling classification. It is defined as the ratio between the space heating demand for a designated heating season, supplied by a heater and the annual energy consumption required to meet this demand, expressed in %</td></tr>
</table>
ESTIMATION OF ENERGY PERFORMANCE FOR ROOM HEATERS
Heat load would be calculated as the sum of heat content within the room and energy losses occurring due to poor insulation in the space.

Heat load = Heat content within the room + energy losses (due to poor insulation)

<u>Deductions:</u>
<u>Deduction 1: Calculating Heat content within room</u>
Heat content within the room or space is the product of mass of air, specific heat of air, and difference in temperature before switching on the appliance and after switching off the appliance.

Heat content within the room= M x C_p x ▲T
Where: M = Mass of air
C_p = specific heat of air
▲T = (temperature before switching ON the appliance - after switching OFF the Appliance)
a) Mass of Air would be obtained by multiplying density of air and volume of air inside the room.
So, Mass of air = D x V
Volume of room = (Length x breadth x height) of room
= 7.5m x 3.5m x 2.85m = 74.8 cum
Density of dry Air = 1.2041 kg/m^3 at 20°C and pressure 101.325kPa
</td></tr>
</table>

APPLIANCE	SPECIFICATIONS
	b) Specific heat of air C_p is 0.2399 kcal/ (kg °C) at 20°C, and pressure 101.325kPa. **Measurement details** ► Distances like length, bread and height to be measured using laser distance meter; ► Temperatures for different scenarios are required to be taken using thermo-hygrometer, as demonstrated in instrumentation section above. <u>Deduction 2: Calculating energy losses due to poor insulation</u> Surface Energy loss is estimated as a product of total surface area, U value of the insulation material, and the difference in temperature between ambient temperature and actual room temperature. **Surface energy loss = A x U x ▲T** Where, A = Total surface area (sq M) U = Relevant U-factor (W/sq M °C) of the insulation ▲T = Difference between ambient temperature and actual room temperature (°C) **Total wall surface Area of the room = 2 x (Length + breadth of room) x height of room = 2x(7.5 m + 3.5 m)x 2.85m = 62.70 sqm** U value is a measure of heat loss. It is expressed in W/m^2 °C, and shows the amount of heat lost in watts (W) per square meter of material when the temperature (k) outside is at least one degree lower. The lower the u value, the better the insulation provided by the material. U values may be obtained from ASHRAE Fundamentals Handbook. **Measurement details** ► Distances like length, and breadth to be measured using laser distance meter; ► Temperatures for different scenarios are required to be taken using thermo-hygrometer, as demonstrated in instrumentation section above. **<u>Results</u>** Energy performance of the appliance under testing is estimated by the following formula: **Energy performance 1 = heat load/ energy consumption (kCal/kWh)** **Energy performance 2 = heat content/ energy consumption (kCal/kWh)** ► Heat load is calculated using above methods (heat load in Cal = energy losses + heat content); ► Heat content takes care of the losses happening through the appliance and also provides an estimation of energy performance of the appliance; ► Units of Electricity Consumption (in kWh): actual kWh consumption during the trial period. **Measurement details**

APPLIANCE	SPECIFICATIONS

- Electricity consumption to be measured using Power Analyzer with wide Frequency range & Harmonics Measurement as explained in earlier section.

THE EUROPEAN UNIONDERIVED AND APPROVED CALCULATION FORMULA:

The calculation formula for space heaters and fuel boiler combination heaters is: **ηs = 0.85η1 + 0.15η4 − ΣF(i),**where:

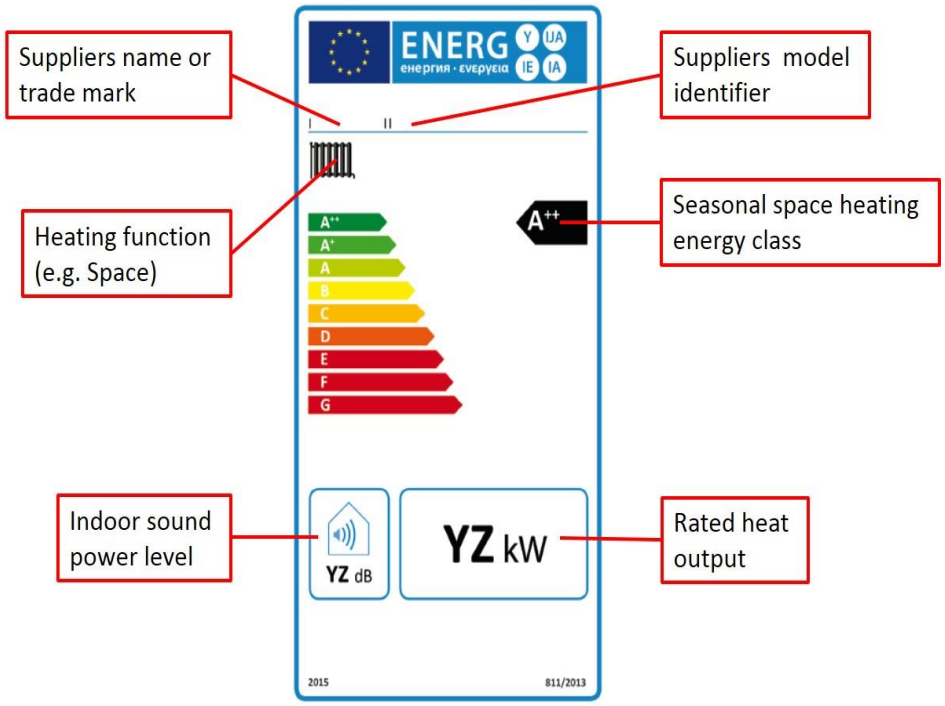
- ηs is seasonal space heating energy efficiency, expressed in %,
- η1 is useful efficiency at 30% of the rated heat output, expressed in %,
- η4 is useful efficiency at rated heat output, expressed in % and F(i) are relevant corrections.

Rating calculator:

Seasonal space heating energy efficiency class	Seasonal space heating energy efficiency η_s in %
A+++	$\eta_s \geq 150$
A++	$125 \leq \eta_s < 150$
A+	$98 \leq \eta_s < 125$
A	$90 \leq \eta_s < 98$
B	$82 \leq \eta_s < 90$
C	$75 \leq \eta_s < 82$
D	$36 \leq \eta_s < 75$
E	$34 \leq \eta_s < 36$
F	$30 \leq \eta_s < 34$
G	$\eta_s < 30$

Illustration: As per EU standards

- European Union follows seasonal space heating as an efficiency parameter
- Seasonal space heating efficiency % is the parameter mentioned in the labels.
- Higher efficiency % signify better or more efficient performance under similar temperature conditions

APPLIANCE	SPECIFICATIONS
	European Union Label: 

Lighting Lamps

Type	LED Bulbs: 7 W
Colour temperature	5000K or 2700K
Power consumption	7 W+/- 10%
Lumen output	Around 650 lm or 500 lm
Luminous Efficacy	around 80lm/W or around 65lm/W
CRI	75-80

Type	LED Bulbs: 9 W
Colour temperature	5000K
Power consumption	7 W+/- 10%
Lumen output	600 lm
Luminous Efficacy	around 75lm/W
Colour Rendering Index (CRI)	75-80

A. Light Emitting Diode (LED) Classic Lamps

Product group covered:	Energy efficient LED classic lamps, which can directly replace incandescent lamps and halogen lamps. Product lists are structured by lamp base (E27 and E14). Retrofit lamps have integrated control gear operated on main voltage (230 volts).

Type	Best example (lm/W)	Inefficient model (lm/W)	No. times more efficient
E27 less bright	86	12	6.2
E27 medium	82	15	4.5
E27 bright	114	16	6.1
E27 very bright	85	17	4.0
E14 classic shape	86	9	8.6
E14 candle	83	9	8.2

The lamp life (h) of the best models ranges between 30,000 and 50,000 depending on the type of lamp. Comparable inefficient models last for between only 2000 - 3000 hours and would therefore need to be replaced between 10 and 20 times during the lifetime of one

(Source: Guidelines for Frontrunner Public Procurers)

Type	Down light LED Bulbs: 9 W
Colour temperature	5000K or 2700K
Power consumption	9 W+/- 10%
Lumen output	Around 550 lm or 450 lm
Luminous Efficacy	around 80lm/W or around 65lm/W
CRI	75-80

B. Light Emitting Diode (LED) - Down lights

Product group covered:	Energy efficient LED spots or "reflectors" (as opposed to LED Classic Lamps), which can directly replace incandescent lamps and halogen lamps. Product lists are structured by lamp base (E27, E14, GU10, GU5.3 and G53). They have integrated control gear operated on main voltage (230 volts).

Category	Best Topten model (lm/W)	Comparable fluorescent lamp (lm/W)	No of tims more efficienct
E27 / E14 medium	58	6	8.7
E27 / E14 (very) bright	73	7	9.4
GU10 medium	79	6	12.2
GU10 bright	85	7	11.1
GU5.3 medium	88	12	6.3
GU5.3 bright	62	14	3.4

(Source: Guidelines for Frontrunner Public Procurers)

Rating Calculator - (Tubular Fluorescent Lamps)

STAR RATING	★	★★	★★★	★★★★	★★★★★
Lumens per Watt at 0100 hrs of use	<61	>=61 & <67	>=67 & <86	>=86 & <92	>=92
Lumens per Watt at 2000 hrs of use	<52	>=52 & <57	>=57 & <77	>=77 & <83	>=83
Lumens per Watt at 3500 hrs of use	<49	>=49 & <54	>=54 & <73	>=73 & <78	>=78

Illustration: As per Indian standards

Rating Calculator - (Compact Fluorescent Lamps)

Compact fluorescent Energy Efficiency Ratio (Compact fluorescent No.5)		
Watt	Minimum efficiency Lumen/Watt color temperature less or equal 4,400 K	Minimum efficiency lumen per watt color temperature more than 4,400 K
5 to 8	50	45
9 to 14	55	50
15 to 20	60	55
21 to 24	60	60
25 to 60	65	60

Illustration: As per Thai standards

Minimum Allowablwe Statndards for procurement

Light source	Minimum allowable luminous efficacy (lm/W)
CFLs	50
LEDs	50
Fluorescent lamps	75
Metal halide lamps	75
High-pressure sodium vapor lamps	90

Illustration: As per Indian standards

- Luminous Efficacy or Lumen per Watt (Lm/W) is the parameter used to determine the star labels of the appliance.
- Luminous efficacy is a measure of how well a light source produces visible light. It is the ratio of luminous flux to power.
- Given the type of bulb, luminosity per wattage of electricity consumed is to be considered by the buyer

Indian Label:

Thailand Label:

Electric Cooking ovens (Convection cookers and Microwave ovens)

Type	Convection cookers, Microwave ovens, etc.
Oven capacity	1.1 cubic feet
Turn table diameter	13 inch
Wattage	850 - 900 Watt
Usual dimensions	29" x 16" x 15"
Rating Calculator	Cooking Energy Efficiency %

- For electric cooking ovens like convection cookers and microwave ovens - Cooking Energy Efficiency % is the parameter mentioned in the labels of the appliance.
- Standard electric convection ovens have a 65 percent cooking energy efficiency and an idle energy rate of 2 kW; whereas ENERGY STAR certified electric convection ovens must meet the specification requirements of 70 percent cooking energy efficiency and an idle energy rate of 1.6 kW.

Label usually placed here and provides annual expected energy consumption; often given monetary values

Electrical cooking devices – Rice cookers

Type	Closed Convection heating – **Rice cooker**
Oven capacity	1.2 to 3.5 litres
Wattage	700 to 1,200 Watt hour depending on capacity

Rating Calculator

$$\eta = \left[\frac{(M_w \times C_{pw} \times (T_f - T_i)) + (M \times C \times (T_f - T_i))}{3600 \times E}\right] \times 100$$

η Is Heat efficiency (%)

M_w Is Mass of water for test procedure (Kg)

M Is Mass of inner substance (Kg)

T_i The initiate water temperature in Kelvin

T_f Maximum heat capacity of water Kelvin

C_{pw} Heat Capacity of water (Kj/Kg*Kelvin)

C Heat Capacity of substance material

E Electricity Kw-Hr

Efficiency criteria ratio for 1.8 liter Rice Cooker	
Electricity use or 1 round cooking(Watt-Hour)	Efficiency Criteria
More than300	1
315 - 330	2
285 - 315	3
270 - 285	4
Less than270	5

Illustration: As per Thailand standards

- Efficiency Criteria ratio is the parameter mentioned in the labels of the appliance.
- The ratio is derived from the cooking efficiency of the appliance.
- Given the capacity in litres, greater the ratio more efficient in terms of energy consumption

The efficiency criteria and energy consumption is mentioned in the labels of the appliances. Interpretation becomes difficult if mentioned in Thai language. Therefore, language barrier should be considered by the manufacturers in this case.

Thailand labels

รูปที่ 1 ขนาดย่อส่วนของฉลากแสดงระดับประสิทธิภาพอุปกรณ์ไฟฟ้า
(ขนาดจริง:กว้าง 58 มม. สูง 73 มม.)

Electrical cooking devices – Curry Cookers

Type	Convection heating – **Curry cookers**
Oven capacity	1.5 to 4 litres
Wattage	800 to 1,500 Watt hour depending on capacity
Rating Calculator	Rating Calculations same as other electrical cooking devices as described above. Labelling is the same as those of other electrical cooking devices and standards set on 'efficiency criteria' as mentioned in the list for rice cookers.

Thailand labels

Electric Water Heater

Type	Electric Water Heater - Electric Pot
Wattage	500 to 1,000 Watt hour depending on capacity

Rating Calculator

$$\eta = \frac{Mw \times Cpw \times (Tf - Ti)}{3600E} \times 100$$

η is the energy efficiency ratio of heating, %

Mw is mass of water in testing, Kg

Cpw is the specific heat capacity of water, 4.187 Kg Joule/ Kg-Kelvin

Ti is the initiate water temperature, Kelvin(K)

Tf is the final water temperature ,Kelvin(K)

E is the total electricity consumtion ,Kilo Watt / Hour (kW-h)

Illustration: As per Thailand standards

- Efficiency percentage is the parameter mentioned in the labels of the appliance.
- The ratio is derived from the heating efficiency of the appliance.
- Efficiency calculations take capacity into consideration, hence one does not have to look for different efficiency for different sizes

Thailand Label:

รูปที่ 1 ขนาดย่อส่วนของฉลากแสดงระดับประสิทธิภาพอุปกรณ์ไฟฟ้า
(ขนาดจริง:กว้าง 58 มม. สูง 73 มม.)

The efficiency criteria and energy consumption is mentioned in the labels of the appliances. Interpretation becomes difficult if mentioned in Thai language. Therefore, language barrier should be considered by the manufacturers in this case.

Computers

Type	Desktop/ laptop
Wattage	60 -120 Watt-hour +/- 10%
Typical Energy Consumption (TEC):	E_{TEC} (kWh) = (8760/1000) * (Poff * Toff + Psleep * Tsleep + Pidle * Tidle) P refers to the power consumption in sleep, idle or off state where as T refers to the time involved in the same.
Rating Calculator	Illustration: As per Indian standards

	Notebook Computers (kWh)
TEC (kWh)	Category A: ≤ 40.0
	Category B: ≤ 53.0
	Category C: ≤ 88.5
Memory	0.4 kWh (per GB over 4)
Premium Graphics (*for Discrete GPUs with specified Frame Buffer Widths*)	Cat. B: 3 kWh (FB Width > 64-bit)
Additional Internal Storage	3 kWh

- Typical Energy Consumption (kWh) is the parameter mentioned in the labels of the appliance.
- Given the screen size/area, a monitor consumes electricity varying upon the status of the appliances, whether it is on active or sleep mode.
- One should compare the typical energy consumption mentioned in the labe given the size and type (laptop/ desktop) of the machine one wishes to buy or procure.

Indian Label:

Transformer

Type	Distribution Transformer – Oil filled naturally cooled

Star Rating Plan in India

The total losses at 50% and 100% loading shall not exceed the values given below:

Rating	1 star		2 star		3 star		4 star		5 star	
kVA	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)
16	200	555	165	520	150	480	135	440	120	400
25	290	785	235	740	210	695	190	635	175	595
63	490	1415	430	1335	380	1250	340	1140	300	1050
100	700	2020	610	1910	520	1800	475	1650	435	1500
160	1000	2800	880	2550	770	2200	670	1950	570	1700
200	1130	3300	1010	3000	890	2700	780	2300	670	2100

Illustration: As per Indian standards

- Total lossat percentage loading is the parameter mentioned in the labels of the appliance.
- Phase-wise the energy efficiency parameter will differ. Therefore, comparison should be on the basis of the number of phase of this equipment.

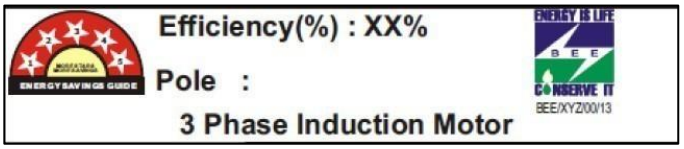
Indian Label:

Motors

Type	Induction Motors-Three Phase Squirrel Cage
Features considered for efficiency	• Measurement of winding resistance (b) • No load test at rated voltage(c) & at different voltages to compute friction & windage losses. • Full Load test (g)
Wattage	750 – 1500 Watt-hour +/- 10%

- Efficiency percent is the parameter mentioned in the labels of the appliance.
- Phase-wise the energy efficiency parameter will differ. Therefore, comparison should be on the basis of the number of phase of this equipment.

Indian Label:



DETAILS OF THE SAMPLE

Rated Output	kW	Rated Voltage	V	Current	A
EFF. Class		Frequency	Hz	Speed	rpm
Efficiency (%)		No. of Phases		No of Pole	
Class of insulation		Type of Duty		Type of Encl.	
Connection		Power factor		Degree of protection	IP
Type of motor	Induction motor	Frame size		Method of Cooling	IC
Ref.Std No.	IS 12615-2011	BIS Cert. Mark (Licence Number if any)		Mounting	
Motor Srl No.				Year of Manuf.	

3. Minimum Compliance Label for the Appliances from various countries

For an effective energy efficiency S&L program, there is a need to develop standards for appliances. It is advisable that Bhutan should adopt energy efficiency standards of neighboring countries. The rationale behind not developing separate energy efficiency standards for Bhutan is:

a. Small market size;
b. Absence of local manufacturing of electrical/ white goods;
c. Limitations of Bhutan standards.

For those appliances which have standards in other importing countries, Bhutan may adopt the Minimum Energy Performance Standard (MEPS) of the country / countries from which majority of appliances are imported and set it as the MEPS of Bhutan. Similar method can be adopted for the Highest Energy Performance Standard (HEPS). For example, if air conditioners are imported mainly from India and Thailand then acceptable range can be:

- Thailand ACs has Energy Efficiency Ratio (EER) of 2.53 - 4.1and India allows 2.7 to 3.5, while Chinese ACs has a higher limit of 4.5 EER, therefore Bhutan can allow products with EER of 2.53 – 4.1.

Table 1: Accepting Standards of the major exporting countries

Air Conditioner	**Energy Efficiency Ratio (EER)**	**Thailand EER**	**India EER**	**Bhutan EER**
		2.53 - 4.1	2.7 - 3.5	Allow import of products with EER 2.53 – 4.1

Source: EY analysis (2015)

For those appliances which have standards only in one of the countries (among major importers), it is justified to comply with the existing standard of that country. If standard exists in India and not in Thailand, Bhutan should comply with the standards in India. Initially, the program can be voluntary in nature and would allow alliances with and without labels to be imported. Once, market transformation happens for the appliances, mandatory compliance can be executed.

Table 2: Illustrative list of existing EE S&L programs that are relevant to Bhutan

Appliance	Comparative Parameter	Countries with existing standards	Rated Standards to be allowed
Washing Machine	Total energy consumption per kilogram of clothes in the machine being washed (kWh/kg)	India Thailand China European Union	Allow import of products withtotal energy consumption of .0126 kWh per kilogram of clothes

Appliance	Comparative Parameter	Countries with existing standards	Rated Standards to be allowed
Television	Kilowatt consumption per screen area	India Thailand China European Union	Products below 311 kWh per year for 175 square inch area of screen
Geyser	Standing Losses (kWh/24hour/45^{o}C difference)	India China European Union	Products below 0.83 standing losses for 25 litres (most common in households)
Fan	Service Value (cum/min/W)	India Thailand China European Union	Products above service value 4
Air conditioner	Energy Efficiency ratio	India Thailand China European Union	Products with EER 2.5 – 4.5
Refrigerators	Comparative Energy Consumption (CEC)	India Thailand China European Union	Products with CEC greater than or equal to (0.29*Adjusted volume + 249) kW per year not exceeding 400 kWh
Room heater	Heating efficiency %	European Union	Products with heating efficiency greater than 80%

Appliance	Comparative Parameter	Countries with existing standards	Rated Standards to be allowed
Lighting Lamps	Lumen per Watt (Lm/W)	India Thailand China European Union	▶ LED lamps with lm/W of greater than or equal to 75 lm/W ▶ FTL lamps with lm/W of greater than or equal to 75 lm/W ▶ CFL lamps with lm/W of greater than or equal to 55 lm/W ▶ Sodium vapour lamps with lm/W of greater than or equal to 90 lm/W ▶ Metal halide lamps with lm/W of greater than or equal to 75 lm/W ▶ All ballasts installed shall be electronic or low copper ballast
Electric cooking ovens	Cooking Energy Efficiency %	India Thailand China European Union	Products withCooking Energy Efficiency greater than or equal to 70%
Rice cooker	Efficiency Criteria ratio	Thailand China European Union	Products withenergy efficiency criteria of greater than or equal to3
Curry cooker	Efficiency Criteria ratio	Thailand China European Union	Products withenergy efficiency criteria of greater than or equal to3
Electric Water Heater	Energy efficiency in heating(%)	Thailand China European Union	Energy efficiency of electric potsof all sizes greater than or equal to 93%

Appliance	Comparative Parameter	Countries with existing standards	Rated Standards to be allowed
Computers	Typical Energy Consumption (kWh)	India Thailand China European Union	Products with less than 40 kW per hour consumption in active setting
Motors (3 phases)	Efficiency percent	India Thailand China	Products with efficiency of greater than or equal to 74% (4 stars and above in Indian Standards)
Distribution Transformers	Total losses at different capacities	India Thailand China European Union	Total losses should be less than: ► 135 Watts for 50% loading ► 440 Watts for 100% loading for 16Kv capacity ► 190 Watts for 50% loading ► 635 Watts for 100% loading for 25Kv capacity ► 475 Watts for 50% loading ► 1650 Watts for 100% loading for 63Kv capacity ► 475 Watts for 50% loading ► 1650 Watts for 100% loading for 100Kv capacity ► 670 Watts for 50% loading ► 1950 Watts for 100% loading for 160Kv capacity ► 780 Watts for 50% loading ► 2300 Watts for 100% loading for 200Kv capacity

4. Comparative Analysis of Standards of Import Countries: India and Thailand

Bhutan comparatively witnesses small annual appliances requirement due to low population and the required number of appliances are imported from two countries, mainly India and Thailand. However, it is to be noted that both countries have their individual methodology for setting the standards. Therefore, it is necessary to review in greater detail the existing standards of the countries from where the appliances are being imported.Those appliances which do not have standards in either of the countries will need a standard to be developed in Bhutan. The standards specification has to be devised and the exporting countries have to comply with the standard to continue exporting and have the appliances tested in laboratory to provide valid certificates of compliance.

Table 3: Presence of Standards for appliances in Thailand and India

Appliance Name	Thailand	India	Bhutan
Fan			adopt existing standard
Television			adopt existing standard
Washing Machine			adopt existing standard
Computers			adopt existing standard
Motors			adopt existing standard
Transformers			adopt existing standard
Lighting Bulbs			adopt existing standard
AC			adopt existing standard
Geyser			adopt existing standard
Rice Cooker			adopt existing standard
Refrigerator			adopt existing standard
Water Boiler			adopt existing standard
Electric Room Heater			New standards required (exists in EU products)Bhutan can adopt EU standards. Once standards are implemented in countries like India and Thailand, the same can be integrated. However, the program may have to continue in voluntary program format till market transformation happens.

	Standards Exist
	Standards Do Not Exist

Source: EY analysis (2015)

Appendix-1: Label Types followed in the Major Exporter countries

It is useful to consider how energy labels communicate information to end users. There are two main types of energy labels:

- **Endorsement:** This type of label merely informs the consumer that the product meets a required standard or benchmark. Endorsement labelling programs are mostly in voluntary nature. An Endorsement label may be specifically for energy efficiency or it may be an "eco" label. Eco label programs endorse products that have low impact across a wide range of environmental factors, with energy consumption levels often having a high priority (but not always).

- **Comparison:** This type of label allows consumers to easily assess the comparative efficiency of a product by means of a simple numerical or ranking system. The concept is that it is much easier for a consumer to remember and compare a simple ranking scale (such as 1, 2, 3 or 1 star, 2 stars, 3 stars or A, B, C) for a range of different products than to remember and compare energy consumption values and sizes of individual products of interest. Numbers as a ranking system are often used in preference to Western letters where a country's language and culture is not based on these letters.

Essentially, the visual design support elements used to assist consumer interpretation of comparative labels in use around the world can be grouped into four basic types.

i. Linear Categories:

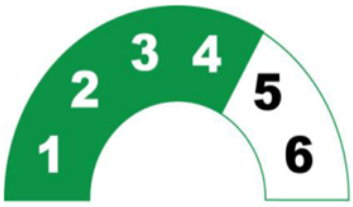
A linear category ranking is the simplest form of label to indicate energy efficiency. The series of examples shown to the right show the same rating of 4 stars, but they do this in slightly different ways. These label examples show stars, but any type of positive indicator could be used – i.e. ticks, numbers, smiley faces, etc. The premise that the label works with is that the greater the number of positive indicator marks, the better the efficiency. The top label uses a simple 1 to 5 star scale, using solid stars. If the rating doesn't reach 5 stars (as in this example), then only 4 stars are shown. The second label indicates a 4 star rating using solid stars as well, although it leaves star outlines if they are not reached by the rating level to help consumers understand the maximum rankings possible. The third label uses a solid star as a place marker to indicate the rating level reached, leaving star outlines on either side of the rating reached. The final label, instead of solid coloured stars, uses white stars and colours around these stars to provide a rating. Japan, ChinaTaiwan, United Arab Emirates, Vietnam and Singapore all use a label design of this general design type.

ii. Dial Categories:

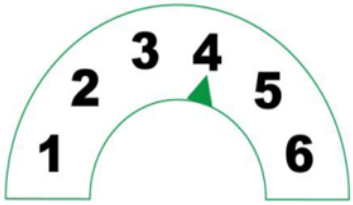
A dial label is simply a set of possible ratings that fan out across a curve. Generally a clockwise indication is an indicator of a more positive attribute, although in some countries and cultures, an anti-clockwise direction is regarded as 'more positive'. The three example labels below use

numbers to indicate the efficiency level. The labels 2 and 3 use a different marker system to show the level of energy efficiency. Label 1has a colour-filled in section that includes up to the rating level -4, while the Label 2 and 3 has a pointer to show the rating level.

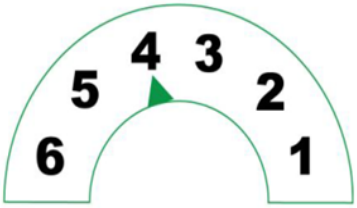
Now for label -1 and 2, the rating of 6 is the most efficient, but any maximum grade can be selected. Label-3 reverses the order of the rating numbers, making 1 the most efficient. This type of system is used by Thailand (5 most efficient, clock wise dial) and Korea (1 most efficient, anti-clockwise dial). The use of numbers (rather than symbols with a positive attribute) means that it is not always clear whether a larger number is better or a lower number is better.



Label -1
The efficiency level increases in the clockwise direction. The green colour-fill is the indicator



Label -2
The efficiency level increases in the clockwise direction. The green colour ticker is the indicator

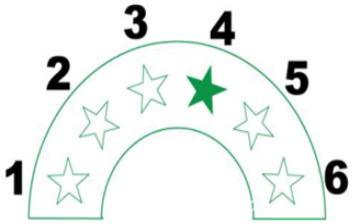


Label -3
The efficiency level increases in the anti-clockwise direction. The green colour ticker is the indicator

A hybrid of the linear categories and the dial design is very commonly used, as these two design elements reinforce each other.

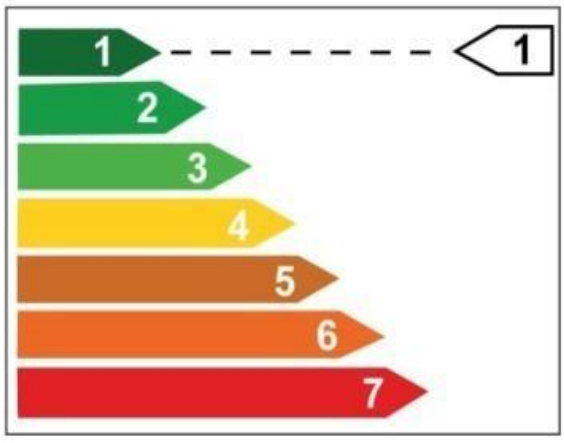
Label -1
A simple 1 to 6 star scale, using solid stars and leaves star outlines if they are not reached by the rating level

Label -2
The label uses white stars and colours the strip around these stars to provide a rating. The rating is determined by extent of colour-fill

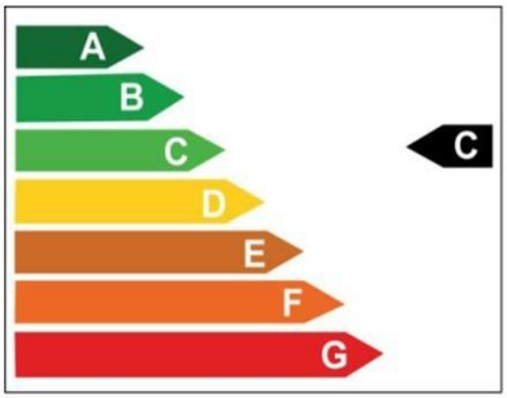


Label -3
Uses a solid star as a place marker to indicate the rating level reached, leaving star outlines on either side of the rating reached, and also uses numbers around the outside of the dial to indicate the rating level

This type of label (or a very similar variant) is used in Australia, Ghana, India, Indonesia, Malaysia, New Zealand, Saudi Arabia (anti-clockwise arc) and Sri Lanka



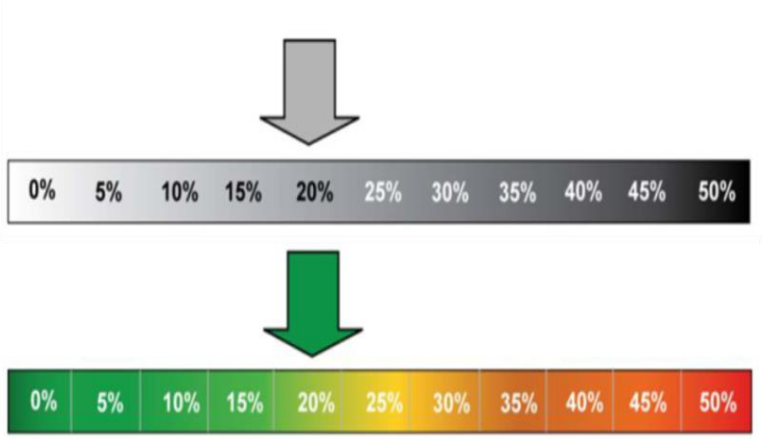
Bar Categories:



This type of label uses a series of bars with a grading from most to least efficient. All grade bars are visible on every label with a marker next to the appropriate bar indicating the efficiency grade of the model. The first label example uses numbers to indicated efficiency levels, with a pointer to provide a rating. The second label simply swaps the numbers for letters (numbers are commonly used in cultures that do not use Western text). The use of colours in the grading system are common (green being perceived a 'good' colour (environmental, the 'go' colour on a set of traffic lights etc.), while red is a 'bad' colour ('stop' on traffic lights or a warning colour)). The length of the bars is also a communicating element (which in effect represents energy consumption rather than efficiency). This label is used primarily in Western and Eastern Europe, Russia, South America, South Africa, in some parts of the Middle East and North Africa. This style is also found in China and Hong Kong. The 'EU style' label is used in many countries, indicating that the EU labelling policy has a strong international influence.

iii. Linear Label:

The final label type uses a linear scale indicating the highest and lowest energy use of models on the market, locating the specific model within that scale. As energy is used as the comparator (rather than efficiency), it is necessary to group models into similar size categories for comparison. The first label uses a percentage graduation, and shows that the model uses 20% more energy than the best model in the market, using a white/grey/black colour graduation. The second label operates under the same principle and shows the same result, although uses a green to red colour graduation like that found in the bar label examples.



The last label doesn't use percentages, instead uses a monetary cost, comparing the best model on the market to the worst, generally this cost is calculated over an annual basis. An alternative to this type of linear label is to show energy on a similar scale to operating cost. Operating costs requires a number of assumptions regarding tariffs, and so needs to be updated from time to time. Energy consumption values also need to be updated on a regular basis as models on the market (scale end points) change. To allow valid comparison of similar products, labels that compare energy or operating cost have to be confined to relative narrow categories of products that are of similar size and with similar features (there are no efficiency categories that take size into account). This form of label is used in the USA, Canada and Mexico.

iv. Other Types of Energy Labels

There are also some other energy labels that have no graphic elements to support the indication of energy efficiency – these generally rely on text to explain the efficiency or some numeric indicator of efficiency (e.g. energy efficiency rating (EER) for air conditioners, or some efficiency ranking). An example of this approach is used in the Philippines and Jamaica (operating cost only).

For the context of Bhutan, it is essential to be specific on the major trading partners as almost all the appliances and equipment are imported. Industry sector is the major electricity consuming sector with about 80% of the energy consumption, followed by the building sectorwhich is expected to increase with the growth of its population, socio-economic development and the rise in the demand for electrical appliances. Reducing the demand for electricity in the residential and institutional segment may help reduce Bhutan's growing demand for electricity. The major import destinations, India and Thailand, contribute largely to the total imports. We are also considering Chinese labels as they have a very large market for appliances and European Union labels because their standard settings are well acknowledged across the world. Chinese and EU labelled products may also get higher prominence with increase in trade with these regions.

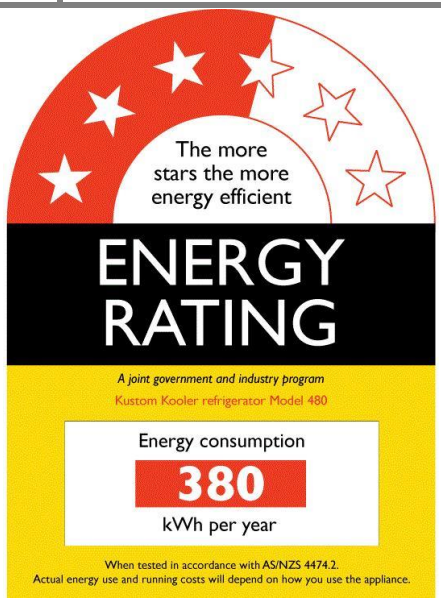
INDIA

The Energy Conservation Act of 2001 provides the basis for India's standards and labelling program. This legislation established the Bureau of Energy Efficiency (BEE), and an Energy Conservation Fund. The legislation enables the provision of the introduction of mandatory labels and standards. This allowed an energy labelling program to be developed in India, which began in 2006 with standards followed shortly afterward. Both of these programs are administered by BEE. The Indian Pollution Control board also runs an eco-label program.

Energy Performance Standards - India

India has introduced voluntary Energy Performance Standards for refrigerators, room air conditioners, fluorescent lamps and distribution transformers. Manufacturers adopting voluntary standards and claiming compliance with the Indian Standard are subject to compliance inspections. Energy Performance Standards for chillers, agricultural pump sets, industrial fans and pumps are currently being developed.

Comparative Label – India	
Program Name:	Comparative Label
Implementing Agency:	Bureau of Energy Efficiency (BEE)
Participation Category:	Voluntary/Mandatory
Appliances Labelled:	2004 – refrigerators and refrigerator-freezers
	2006 - refrigerators and room air conditioners (voluntary)
	2007 - refrigerators (direct cool) (voluntary)

	2010 - refrigerators (frost free), tubular room air conditioners and distribution transformers (mandatory)
	2009 – agricultural pump sets, general purpose 3 phase motors, ceiling fans (voluntary)
	2010 – storage water heaters, clothes washers (voluntary), fluorescent lamps (tubular)
	2011 – laptop computers (became mandatory in 2013)
	2012 – televisions, LED lighting, ballasts – electronic/magnetic (voluntary), CFLs
	2013 - Under review: LPG stoves
	2013 - Under development: set top boxes, voltage stabilisers, uninterrupted power supply (UPS), inverters
Rating System:	Energy Consumption, Efficiency Rating (grade) 1 to 5 stars (5 most efficient)
	

Program Information:

The impetus for the Standards and Labelling program in India came with the passage of the energy conservation bill in October 2001. The Bill allowed for the establishment of Bureau of Energy Efficiency (BEE), India, which was completed in March 2002. India's Standards and labelling program involves multiple cooperating organisations: Ministry of Power (MOP), BEE, Steering Committees, the Technical Committee, and the Bureau of Indian Standards (BIS). BEE develops the labels with input from the Steering and Technical Committees, the label is proposed to MOP, who is then responsible for the execution of the labelling scheme.

India’s labelling program was launched in 2006, initially with a voluntary comparative labelling scheme for refrigerators and air conditioners. The overall strategy was to begin labelling on a voluntary basis, then move to a mandatory approach for energy performance and test procedure standards. BEE's Star Labelling is now mandatory for four appliances, including frost-free refrigerators, room air conditioners, distribution transformers and tubular fluorescent lights (TFLs).

THAILAND

Thailand passed its Demand Side Management (DSM) Master Plan and its Energy Conservation Promotion Act in 1991, with an associated Energy Conservation Promotion Fund in 1992. These two programs have established a strong basis for an increase in the efficient use of energy. Organisations involved in energy conservation include: the Ministry of Energy (MOEN), Electricity Generating Authority Thailand (EGAT), Department of Alternative Energy Development and Efficiency (DEDE), Energy Policy and Planning Office (NEPO), Thai Industrial Standards Institute (TISI), and Electrical and Electronics Institute (EEI), and Thailand Environment Institute (TEI). Currently Thailand has two labelling schemes – a comparative label operated by EGAT for its DSM programs, and an eco-label operated by TEI.

Thailand has recently implemented a long term plan for energy efficiency improvement called the '20 year Energy Efficiency Development Plan (EEDP 2011-2030)'. This plan was developed by the Ministry of Energy, and approved by the Thai cabinet in 2011. Thailand uses both mandatory and supportive/promotional measures, including mandatory Energy Performance Standards and voluntary energy performance labelling for appliances and equipment.

Thailand is also involved in an energy saving regional project (BRESL) that includes five other countries – Pakistan, Indonesia, Bangladesh, Vietnam and China. These six countries have called on the technical assistance of the Global Environmental Facility (GEF) to assess Energy Performance Standards programs for a number of products, as well as support a labelling process. The project also aims to facilitate the harmonisation of test procedures, standards and labels among developing countries in Asia. In Thailand the BRESL project began in 2009 and is implemented with close collaboration with the Ministry of Energy's Department of Alternative Energy Development and Efficiency (DEDE), and the Electricity Generating Authority of Thailand (EGAT). The activities focus on capacity building and assisting government, manufacturing, distribution, retail, consumer and environmental stakeholders to develop and implement cost effective energy standards and labelling programs.

Thailand has active comparative label, endorsement label and Energy Performance Standards programs for appliances and equipment.

Energy Performance Standards - Thailand

The implementing organisation for the Thai Energy Performance Standards program is the Department of Alternative Energy Development and Efficiency, Ministry of Energy (DEDE). The program was first implemented in 2006 for two product types – refrigerators/freezers and CFLs, and has since expanded to cover 4 more product types. Product standards are set by the DEDE and regulated by the Thai Industrial Standards Institute (TISI) under the Ministry of Industry. Suppliers and manufacturers must have their products certified by the TISI, and register either each model or family of models to be able to sell the products in Thailand. Visual checks of registration details are commissioned by the government agency, and verification testing is conducted within the program.

Program Name:	The Energy Efficiency Label
Implementing Agency:	Electricity Generating Authority of Thailand (EGAT)
Participation Category:	Voluntary

Appliances Labelled:	1995 – room air conditioners (split and window wall), refrigerators
	1998 – residential fluorescent lighting ballasts (magnetic ballasts)
	2000 – refrigerator/freezers
	2004 – rice cookers
	2006 – compact fluorescent lamps
	2008 – portable fans
	2009 – fluorescent lighting ballasts (electronic ballasts and low loss magnetic ballasts), lamps
	2010 – kettles, standby (all equipment types)
	2011 – instantaneous water heaters
Label	Energy consumption (RF kWh/year, AC power), rating 1 to 5 (5 most efficient) (in practice on grades 3, 4 and 5 are available) 

Program Information:

Appliance energy labelling in Thailand is operated by the electricity utility (Electricity Generating Authority of Thailand - EGAT), and is a voluntary program. The energy labelling project has been approved by the Thai government and is incorporated into the utility's Demand Side Management (DSM) Program. The program is supported by a very high profile publicity campaign to raise public awareness of energy labels and energy efficiency. The labelling program first came into effect in 1993/94. In order to obtain a label, a product must be sent to the Electrical and Electronics Institute (EEI) for energy performance testing. Suppliers and manufacturers must also complete a registration process for a model or family of models to be able to join the program or sell products under the program. Verification testing for electrical products is undertaken by EGAT.

CHINA

The Law on Energy Conservation of China, was approved by the National People's Congress on 1 November 1997, and came into force on 1 January 1998. It supersedes earlier laws that may have indirectly dealt with energy conservation. The Law aims to achieve the rational and efficient use of energy through enhanced energy use management; the adoption of measures, which are technologically feasible, economically rational and environmentally and socially acceptable; and the reduction of loss and waste in the energy production and consumption chain. The various state agencies responsible for standardisation and certification in the initial stages were:

- China State Bureau of Quality and Technical Supervision (CSBTS) was responsible for the development, implementation and supervision of Energy Performance Standards. CSBTS was later elevated and renamed the State Administration for Quality, Supervision, Inspection and Quarantine (AQSIQ), establishing the Standardization Administration of China to oversee the energy efficiency standards and labelling program in China;
- The State Economic and Trade Commission (SETC) was responsible, with CSBTS, for the development of energy labelling, certification labelling and quality marks. The SETC was later merged with the State Development and Planning Commission to form the present National Development and Reform Commission, which is responsible for implementation of energy efficiency policy;

The government agencies rely on the efforts of the China National Institute of Standardization (CNIS) to develop proposed Energy Performance Standards. In 1999 the China Certification Centre for Energy Conservation Product (CECP) was established to implement a new voluntary endorsement label. In 2005, a mandatory comparative label was introduced and now covers 27 product types. Both the comparative label and certification mark are now managed by the China Certification and Accreditation Administration Department. Standards for these two programs are issued by the Standardisation Administration of China, with standard research undertaken by the China National Institute of Standardisation. Compliance supervision is administered by the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ). China's drive for energy efficiency has a long history and has led to the establishment of mandatory Energy Performance Standards which covers a diverse range of products. China is also involved in an energy saving regional project (BRESL) that includes five other countries like Pakistan, Indonesia, Thailand, Vietnam and Bangladesh. These six countries have called on the technical assistance of the Global Environmental Facility (GEF) to assess Energy Performance Standards programs for a number of products, as well as support labelling processes. The project also aims to facilitate the harmonisation of test procedures, standards and labels among developing countries in Asia.

Energy Performance Standards - China

China's extensive Energy Performance Standards program began in 1989. The administration of the program is conducted by the AQSIQ, the Standardization Administration of China (SAC) and the China National Institute of Standardisation (CNIS).

Comparative Label – China	
Program Name:	China Energy Label
Implementing Agency:	National Development and Reform Commission (NDRC) and the General Administration of QualitySupervision, Inspection and Quarantine of China (AQSIQ)
Participation Category:	Mandatory

Appliances Labelled:	2005 – refrigerators, air conditioners (fixed speed)
	2007 – clothes washers, unitary air conditioners
	2008 – self ballasted fluorescent lamps, high pressure sodium lamps, electric motors, gas water heaters, water chillers
	2009 – central air conditioners, storage water heaters, induction cooktops, conditioners (variable speed) computer monitors, copy machines, air
	2010 – ceiling fans, automatic rice cookers, industrial blowers,
	2011 – transformers, microwaves, televisions
	2012 – printers, fax machines, solar water heater
Rating System	

Program Information:

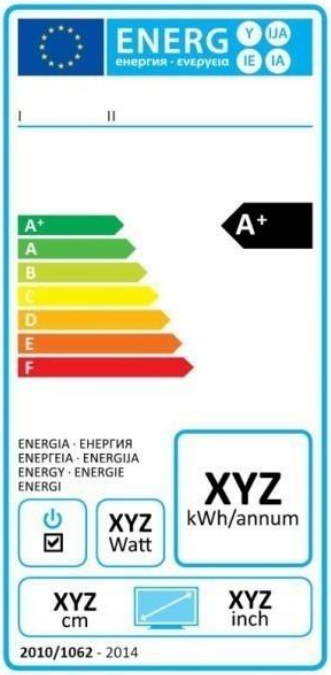
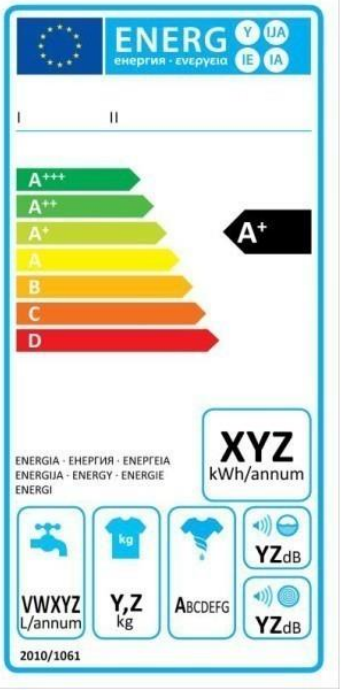
The administration of the program is conducted by the AQSIQ and the NDRC. Based on efficiency standards, China uses an ‘energy efficiency labelling management approach’, which is designed to enhance the interaction of producers, and guide consumers to purchase energy efficient products, while promoting producers to use energy efficient technologies. The program was introduced in 2005, with products added through ‘product catalogues for labelling’. The China Energy Labelling Centre (CELC) is the implementing department for the label. In order for suppliers for manufacturers to join the program, a test report that is registered with the CELC needs to be provided, as well as a self-declaration of energy performance and a completed registration for each model to carry the label. Stores and suppliers are responsible for ensuring compliance.

EUROPEAN UNION

The introduction of Energy Performance Standards in Europe was problematic initially, with the European Union members initially needing to gain approval from the EC and the Parliament, in order to introduce or revise mandatory energy efficiency standards for any product. When the Netherlands initially proposed a national standard for refrigerators, it was rejected on the grounds that it would be prohibitive to free trade agreements. Prior to 2009, only three products had mandatory standards. In 2009, the EU adopted the Directive 2009/125/EC on Eco-Design, aimed at reducing the environmental impact of products, including the energy consumption throughout their entire life cycle. This Directive established a framework for the setting of Eco-Design requirements for energy related products, however made no direct provision for mandatory requirements for specific products. Mandatory requirements are developed for individual products via implementing measures and voluntary agreements. Since the adoption of the Directive 2009/125/EC, mandatory Energy Performance Standards have been established for many electrical appliance categories.

Further products under consideration for Energy Performance Standards include: game consoles, tunnel washers (commercial), DVD and Blue Ray players, commercial refrigeration – all types, ovens, central air conditioners, ice machines. Energy Performance Standards have been developed and is awaiting implementation for coffee machines.

Comparative Label – European Union	
Program Name:	Energy Label
Implementing Agency:	National bodies of EU member Countries
Participation Category:	Mandatory
Appliances Labelled:	1994 - refrigerators, refrigerator-freezers and freezers (94/2/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 1060/2010)
	1996 - clothes washers (95/12/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 1061/2010), clothes dryers (95/13/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 392/2012)
	1997 - combination washer-dryers (96/60/EC)
	1998 – dishwashers (97/17/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 1059/2010), lighting systems (92/75/EEC)
	2000 – electrical lamps and luminaries (98/11/EC) (revised with 2010/30/EU and again with Commission Delegated Regulation 847/2012)
	2003 - air conditioners (2002/31/EC), electric ovens (2002/40/EC)
	2010 – Commission Delegated Regulations: 1062/2010 televisions (updating 2010/30/EU)

	2011 – Commission Delegated Regulations: 626/2011 air conditioners (updating 2010/30/EU)
	2013 – Commission Delegated Regulations: 811/2013 space heating equipment, 812/2013 water heaters, 665/2013 vacuum cleaners
Rating System	Energy (kWh/year or per cycle), Efficiency rating A to G (A most efficient), although new label scales generally show a highest rating of A+++ with the lowest rating of D; the visible end scales depend on the product.
  	

Appendix - 2: Evaluation of Energy Efficiency Testing options

In order to ensure adherence of standards of energy efficient appliances in the country, there is a need for testing facilities which would assess the energy performance of the appliances imported, or used in the country. This chapter evaluates different cases considered for setting up of testing laboratory in Bhutan or availing testing facilities in other neighbourhood countries. Setting such a laboratory would require manpower with sound technical knowledge on operating the laboratory and hence considerable investments in building capacity would be required.

To test the appliances, testing laboratories should have a sound infrastructure and should have a separate dedicated team within DRE who will work on product inclusion involving intensive interaction with stakeholders like consumers, test laboratories, industry associations, research institutions, different ministries etc. The team formed should have two major activities under S&L scheme, which will mainly include Monitoring, Verification and Evaluation (MV&E) and capacity building of stakeholders. Central/ Dzongkhag level support is required to develop capacity of the teams and provide them with appropriate number of resources having the expected quality. A detailed plan has to be prepared for training officials on S&L programme with yearly updating. However, before developing any capacity building exercise, a detailed need-assessment and gap-analysis of the employees should be conducted. It is technically and financially not viable to set up a full-fledged testing laboratory in Bhutan due to the reasons cited earlier. Hence, it is recommended that Bhutan avails of sophisticated testing laboratories in nearby countries like in India which is also the country of maximum imports for testing of appliances, or in Thailand. Till the time such a testing laboratory is set up in Bhutan, the country may explore setting up a basic facility to check operational efficiency of appliances in Technical Institutes, or in DRE premises.

Setting up of an energy testing laboratory in Bhutan has some merits and demerits, which may be discussed in details below.

Merits:

- Testing laboratory in Bhutan would enable the country to avail of testing facilities within close proximity;
- This would lead to savings in terms of time which is required to get the appliances tested in another country using test laboratories in countries like India or Thailand;
- This would facilitate ease of coordination since test lab will be under operational control of Bhutan government.

Demerits:

- Huge capital expenditure and operational costs to be incurred by Bhutan Government if a full-fledged testing laboratory is set up;
- For a small appliance market size of the one like of Bhutan, there is not much need to set up a complete test lab in the country with controlled testing conditions.