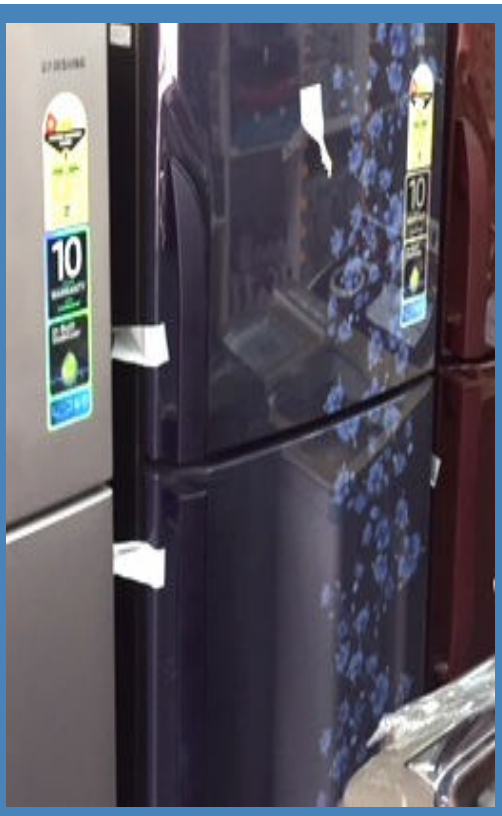
Standards & Labeling Scheme for Energy Efficient Appliances

Baseline and Economic Analysis



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

Preface

This report is a part of the Energy Plus Extended Program under the Asian Development Bank TA-8630 BHU: Promoting Clean Energy Development in Bhutan executed by the Department of Renewable Energy, Ministry of Economic Affairs, Royal Government of Bhutan.

Contents

Abbreviations

A&P	Advertising and Promotion
AC	Air Conditioner
ADB	Asian Development Bank
BCR	Benefit-cost Ratio
BEE	Bureau of Energy Efficiency, Ministry of Power, Government of India
BTC	Bhutan Trade Classification
CEMEP	European Committee of Manufacturers of Electrical Machines and Power Electronics
CFL	Compact Fluorescent Lamp
CRI	Colour Rendering Index
CRT	Cathode Ray Tube
DRC	Department of Revenue and Customs, MoF, RGoB
DRE	Department of Renewable Energy, MoEA , RGoB
EER	Energy Efficiency Ratio
EGAT	Electricity Generating Authority of Thailand
FTL	Fluorescent Tube Light
HID	High-intensity Discharge Lamp
IEC	International Electrotechnical Commission
ISEER	Indian Seasonal Energy Efficiency Ratio
ISO	International Organization for Standardization
L	Litre
LED	Light-emitting Diode
Lm	Lumen
MEPS	Minimum Energy Performance Standards
MoEA	Ministry of Economic Affairs, RGoB
MoF	Ministry of Finance, RGoB
Nu	Bhutanese Ngultrum
RGoB	Royal Government of Bhutan
Rs	Indian Rupees
S&L	Standards and Labeling
TV	Television
UAE	United Arab Emirates

1 Energy Standards and Labels

1.1 Background

Bhutan has experienced a fast growth in electricity generation and supply in recent years. Over the past decade, electricity consumption has more than doubled, which to a high degree is a result of the extensive electrification works in the country.

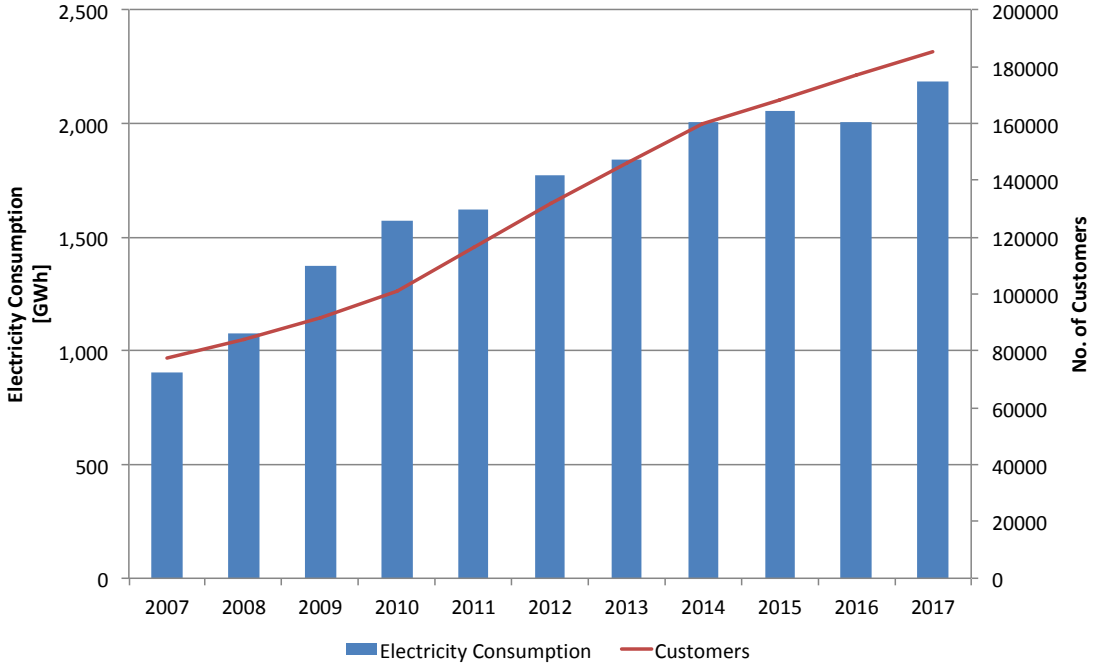


Figure 1 Electricity consumption and number of customers in the period 2007-2017 (Bhutan Power Corporation Limited).

Electrification coverage in Bhutan has now reached 99.97%[1]. Electricity consumption may see a slower increase in the coming years, as less new customers are being connected to the grid, but existing customers are expected to continue to increase their consumption due to economic prosperity and higher living standards. The assumed increase in consumption is conservatively forecasted to be 3.5% p.a., which is based on the lower growth rates experienced in the past 5 years.

[1] Power Data Book 2017, Bhutan Power Corporation Limited.

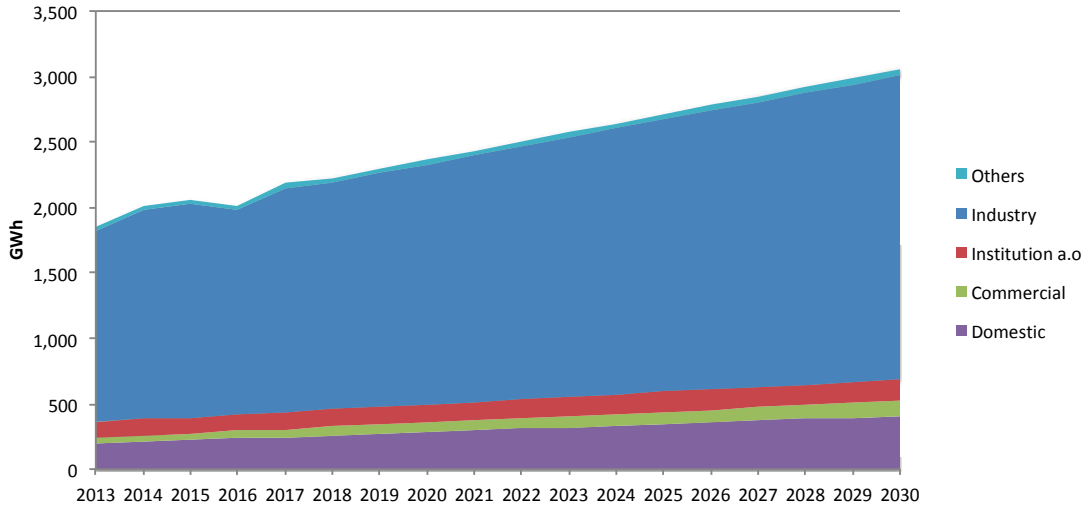


Figure 2 Forecast of electricity consumption based on 3.5% annual growth rate from 2018 and onwards.

There are no forecasts on the sales of appliances, so the expected increase in the stock of appliances is conservatively projected to follow the same 3.5% p.a. increase, as the future growth in electricity consumption will derive from more electrical appliances and equipment being installed and used by consumers.

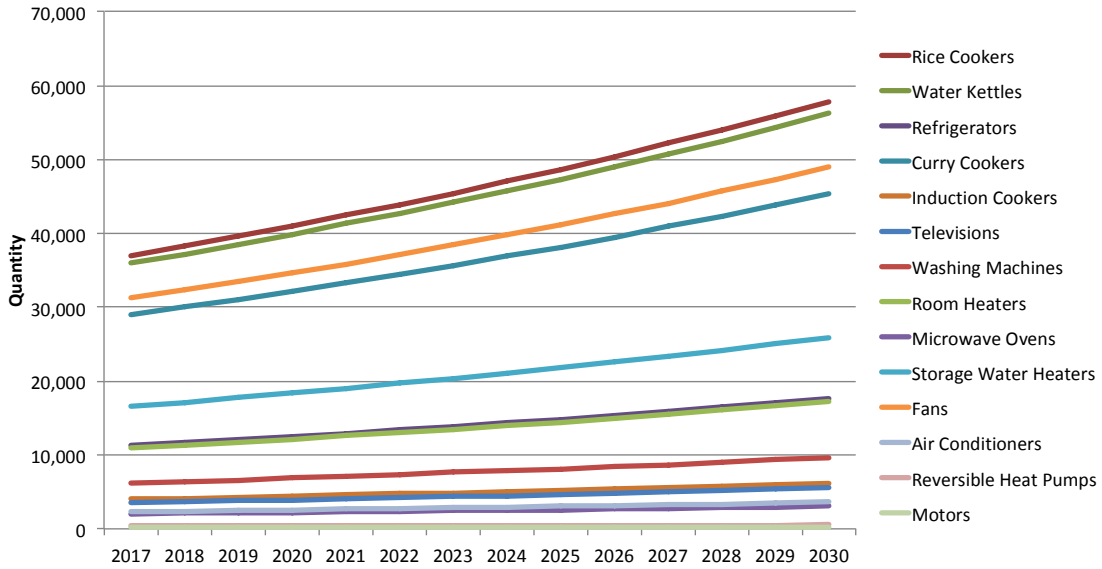


Figure 3 Expected growths in sales of appliances based on expected growth in electricity consumption of 3.5% p.a.

Electrical appliances improve comfort, productivity and quality of life for the users. However more efficient appliances at lower energy consumption can achieve the same output and service for the user. Therefore, it is important to observe the efficiency of the new appliances entering the market and inform buyers about the energy consumption and life cycle cost, so that it is not only the purchase price and product features that are determining their purchase. The objective of the standards and labeling scheme is to drive and transform the market towards higher energy efficient products and contribute towards improving energy productivity of the country.

1.2 Introduction to Standards and Labeling

Major efforts are done internationally to harmonise standards for energy performance in order to avoid trade barriers, which can lead to high transaction costs for specific testing and certification of equipment, thus leading to higher consumer price for goods.

The Bhutanese economy is relatively small. Introducing a specific S&L scheme with its own testing standards could distort the market for the range of products, as some manufacturers may find the transaction costs associated with a specific test of their products for the Bhutanese market, too expensive compared to the potential sales revenues. Further, the Country needs to make significant investment for effective management of the scheme.

In this context, instead of developing independent standards and energy performance labels, Bhutan could adopt standards of major trading partner countries, for example, India. Adopting standards of certain countries does not mean that imports will be restricted to only these countries. Goods from other countries can still be imported if the products are tested in accordance with the relevant test standards adopted by Bhutan. Such approach will reduce the implementation cost to Bhutan and moreover, manufacturers will be willing to carry out tests, as it will also help the manufacturers to penetrate larger regional markets.

An S&L scheme comprises of two major elements: 1) appliance testing to reveal the energy performance or energy consumption and 2) the rating of performance that determines a minimum performance level allowed and ranking of performance in energy efficiency level (e.g. energy star ratings).

The first element, the testing, can be based on international test methods and standards such as ISO or IEC, while the second element, the rating, can be determined at national or adopt other suitable scheme.

The regulation of an S&L scheme can have the following three interventions:

1) Minimum energy performance standards (MEPS), sets the lower limit for energy efficiency of products to enter the market. MEPS require an effective control and regulatory mechanism for approving products for import and must have strong enforcement of the MEPS in order to be effective.

2) Comparative energy performance labeling or rating provides information to the consumers to compare the energy performance of appliances at the point of sale and allow the consumers to assess the life cycle cost of products. This can be implemented on either voluntary or mandatory basis backed by legislation and enforcement.

3) Endorsement labelling, recommends consumers about the best products in their category by a label. This label will focus the consumer's attention to the most energy efficient products and make energy efficient procurement simpler. Endorsement labels

are normally voluntary and will be driven by the interest of suppliers to further promote their products as energy efficient by the endorsement label.

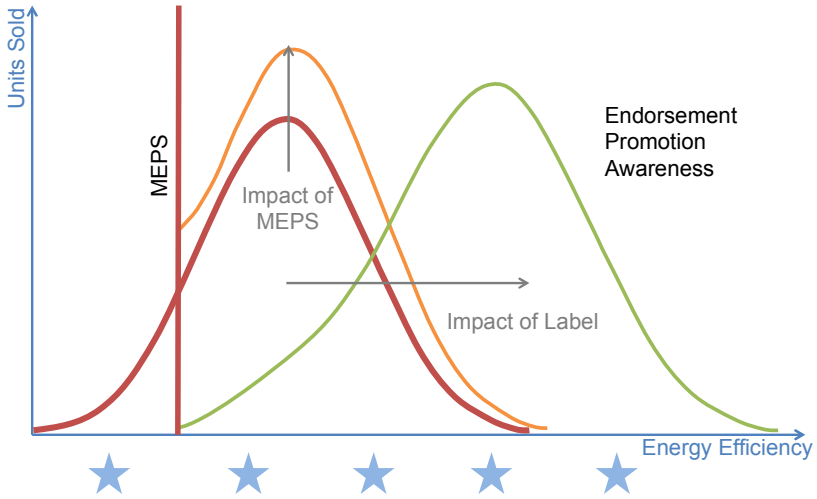


Figure 4 Illustration of the market transformation as a result of MEPS and labeling.

The figure above shows the expected market transformation as a result of the 3 interventions described above.

The red curve shows the baseline sales of an appliance, where most products sold are in the 1-3 stars range. With the introduction of MEPS and eliminating 1-star appliances from the market, the market will see a shift upwards in sale of the 2-3 star products take market share of 1 star products. This is illustrated by the orange curve.

With introduction of energy rating, comparative labelling, and promotion of 5-star energy efficient products by endorsement, the market demand will pull towards higher efficiencies. This is illustrated by the green curve. Proper promotion of energy efficient appliances will increase the sale of high efficiency products and automatically reduce the sale of lower stars and less efficient products.

If more efforts are made to promote energy efficient products in the market, it may reduce the need for implementation of MEPS as the low-efficient appliances will be in low demand and will naturally be eliminated from the market. When the market sale starts the transformation towards higher energy efficiency products, the concerned agency may consider introducing the MEPS. Most countries have introduced a rating and labeling scheme first on a voluntary basis, and only later made it mandatory and set MEPS to eliminate the low energy efficient appliances.

1.3 Appliance Market

Electrical appliances sold in Bhutan are all imported. Majority of the import is from neighbouring country, India. Electrical appliances from Thailand, China and other countries are also found in the Bhutanese market. There are a few major importers licenced by the

Government that serves as the wholesale dealer importing directly from manufacturing companies of other countries. In addition, there is a small portion of appliances being directly imported by individuals for personal use but this quantity is not considered substantial. The large electrical appliances such as refrigerators, air-conditioners, washing machines, TVs, etc., are sold in dedicated electrical outlets. Smaller kitchen appliances, such as rice cookers, microwave ovens, mixers, etc., are sold in shops selling kitchenware or in supermarkets.

As the Country does not manufacture electrical appliances, the sales volumes are determined from import statistics issued by the Department of Revenue and Customs.

BTC	Appliance	Total Import	Main Import County
8516.21.00	Electric Room Heater	10,911	China (80%)
8418.21.00	Refrigerator	9,584	India (100%)
8516.10.00	Electric Water Heater	31,365	India (45%)
8516.50.00	Microwave Oven	1,922	India (44)
8516.60.00	Cookers	141,176	Thailand (76%)
8,539	All Lamps	718,119	India (99%)
8539.21.00	Halogen	10,049	India (100%)
8539.31.00	Fluorescent, hot cathode	10,632	India (93%)
8539.50.00	LED Lamps	7,101	India (96%)
8,529	Television	3,560	India (72%)
8414.51.00	Fan	31,270	India (97%)
8,450	Washing Machine	6,181	India (97%)
8415.10.00	Air Conditioner	2,325	India (75%)
8415.81.00	Reversible Heat Pump	336	India (46%)
85	Motors 0.75kW - 375kW	178	Japan (40%)

*The import from Japan in 2017 is an abnormality, as the import in previous years is mainly from India.

Table 1 Import of selected electrical appliances in 2017 and identification of main country of origin. (Department of Revenue and Customs, Bhutan Trade Statistics 2017)

Bhutan is experiencing economic growth and the household income is increasing steadily leading to increased sales of electrical appliances. This is due to two factors: 1) the households have increased income and can afford to buy appliances for the first time, and 2) middle income households can afford to install more appliances such as several fans, room heaters, water heaters and more TVs, etc.

The growth in sale of appliances will by default increase the energy consumption, if the efficiency of the appliances that is being sold is not improved. Introduction of energy efficient appliances in the market can stabilize the energy consumption growth or even reduce it as illustrated in figure 5.

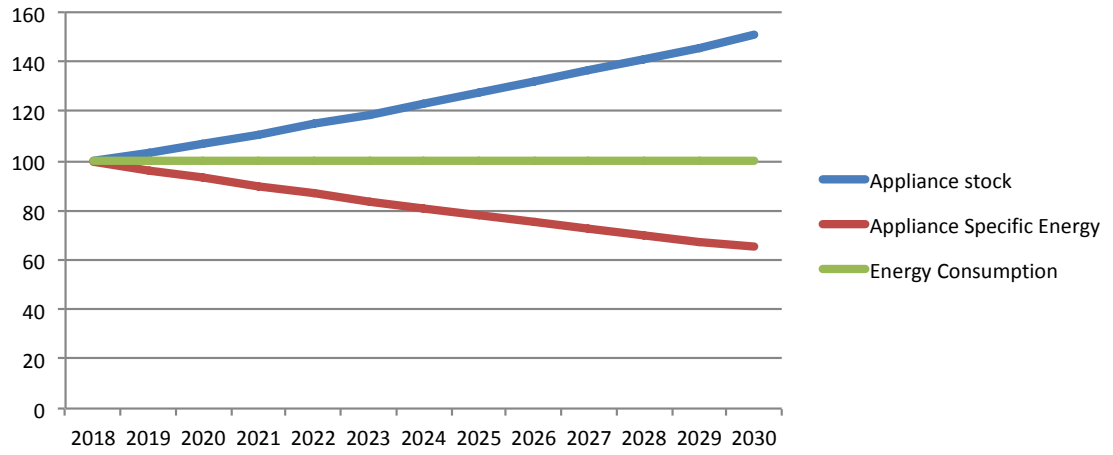


Figure 5 Illustration of how improvement of the energy performance or specific energy of appliances can stabilise the energy consumption.

1.4 Energy Labels in the Market

All appliances sold in the domestic market are imported. The products imported from India are manufactured and packaged for the Indian market. Similarly, products from Thailand are designed and manufactured for the Thai market. As these countries already have standards and labelling in place, many appliances sold in Bhutan do have energy labels from one of these countries affixed. In India it is mandatory to affix the BEE prescribed energy label to certain appliances such as refrigerators, air-conditioners, geysers, LED lamps, etc. In Thailand it is voluntary and the labels are mostly displayed on the most energy efficient products (i.e. 5-stars).

A retailer survey was carried out as part of ADB TA 8630, which showed that of the total products surveyed, 57% do not have any energy label; 35% have Indian label energy star labels; and 7% have Thai energy star labels as illustrated in the figure 6. For some appliances (especially from India), there are labels on the majority of models sold in Bhutan, whereas for other appliances, only a few models have labels and mainly those that are rated 5-stars (especially from Thailand). Though many products are labelled, the presence of the highest star rated appliances (e.g. 5-stars) is limited and the retailers do not source and stock these appliances.

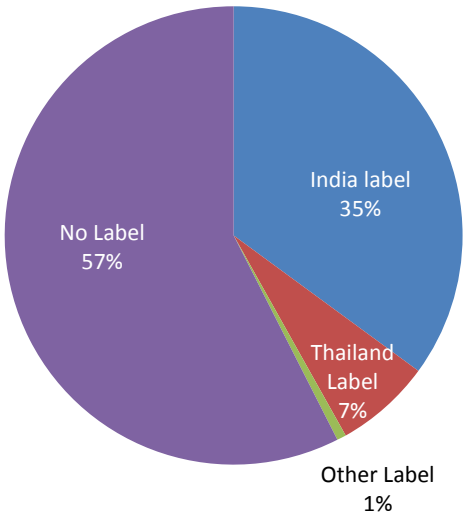


Figure 6 Share of appliances labeled in Bhutan (Based on retailer survey data)

2 Baseline Analysis

The baseline analysis covers most common appliances and equipment sold in the Bhutanese market. The selection of appliances is based on the household survey carried out in 2015[2], which studied the ownership and usage of appliances in 202 households in Bhutan. Electrical motors are also included as this is a standard type of equipment widely used in industries and the power sector. Common for the selection of appliances and equipment for standards and labeling schemes is that they should be widely used and of a standardised design, which means the same service is provided by the appliances and equipment, but where the energy performance varies from model to model.

2.1 Selection of Household Appliances

The household survey covered low-income, medium-income and high-income households. Some appliances such as lamps, rice cooker, water boilers, refrigerators and TV's are found in almost all types of households. In high-income homes there may be more appliances per household compared to low-income homes. As the household income increases additional appliances are purchased and installed, typically: room heaters, storage water heaters (geysers), fans and microwave ovens. These provide additional convenience in the household above the basic needs provided by common appliances. In high-income households it was also found that some had heat pumps/air conditioners to provide room heating and cooling.

The selected 14 appliances from the household survey and related studies carried out in 2014 2015[2] are shown in table 2.

[2] Energy Efficiency for Equipment and Appliances Sector, Department of Renewable Energy, Ministry of Economic Affairs, 2015

No.	Appliance	Ownership
1	Lamps	100%
2	Rice Cooker	96%
3	Water boiler	92%
4	Refrigerator	77%
5	Curry Cooker	75%
6	Television	75%
7	Washing machine	52%
8	Room heater	48%
9	Microwave Oven	47%
10	Storage Water Heater (Geyser)	45%
11	Fan	32%
12	Reversible Heat Pump	17%
13	Mixer-Grinder	9%
14	Air conditioner	1%

Table 2 Ownership of appliances in households (Energy Efficiency for Equipment and Appliances Sector, Department of Renewable Energy, Ministry of Economic Affairs, 2015).

2.2 Retail and Sales Distribution

The sale of appliances is mainly through retailers with an assortment of appliances and brands. The retailers can be categorised as:

1. Electrical Store (specialised in larger household appliances e.g. refrigerators, washing machines, storage water heaters, TV sets, etc.)
2. Household Product Store (specialised in kitchenware, small kitchen appliances e.g. rice cookers, microwave ovens, etc.)
3. Supermarkets (specialised in grocery etc. but with a section for household appliances e.g. rice cookers, mixers, water boilers etc.)

There are very limited brand and chain stores selling household appliances. The only retailers identified which dedicatedly sell electrical appliances is Tashi Commercial (around 10 stores and importer) and Dolma Commercial (2 stores and importer and distributor to retailers) while the only dedicated brand stores that was identified are the outlets for Daikin (air-conditioners and heat pumps) and Jaquar (storage water heaters).

2.3 Baseline Study Methodology

The baseline study is based on primary and secondary data. The secondary data is mainly derived from the annual official trade statistics of Bhutan 2017[3], which is compiled by the Department of Revenue and Customs. This provides data on appliances and equipment that are imported into the country and are registered by the DRC in terms of number of goods and import value. The trade statistic provides data on an aggregated level for all appliances in each

[3] Bhutan Trade Classification & Tariff Schedule, Sixth Edition 2017, issued by Department of Revenue & Customs, MOF, RGoB

trade category. The statistic does not provide specific data on the range of appliances in terms of specific models, sizes, retail price, energy consumption, etc. Therefore, the specific data on model ranges, sizes and prices were collected through the retailer survey conducted by consultants. The survey covered 47 retail outlets in Thimphu, Phuentsholing and Wangdue region and collected data for more than 350 appliances and provides a fair representation of the models and types of appliances available in the Country. The technical and commercial information of the selected types of appliances were analysed using an app-based database. The information collected in the database is shown in table 3:

No.	Parameter	Remarks
1	Brand	Brand name of the appliance
2	Country of Origin	Country from which the appliance is imported
3	Model No./Name	Specific model name or number
3	Model Year	Year of manufacturing
4	Retail Price	Retail price or recommended retail price. Does not include any sales discounts offered
5	Sales in 2017	Sales volume of the model in 2017. This data cannot be obtained in most cases, as the owner does not have the data or is not willing to share it.
6	Type	Specific type of appliances, if more types exist. E.g. direct cool and frost free for refrigerators
7	Size	Size of the appliance. E.g. Gross volume of refrigerators or screen size of TV.
8	Power Rating	Power consumption of the appliance when in operation.
9	Energy Label	If the appliance is already labeled, then origin of the label is registered.
10	Energy rating	Energy star rating of the appliance according to the label
11	Energy Consumption / Energy Efficiency	Energy consumption or other energy efficiency information provided on the label.
12	Pictures of the Appliance	Picture of the appliance and name plates etc.

Table 3 Data collected in the retailer survey

2.4 Importer/Distributor Data

The market for appliances is relatively small and for most household appliances there are two main importers, who supply most of the goods. Together they hold more than 70% of the refrigerator market and more than 50% of the washing machine market. While the retailer survey aimed to collect sales volumes for each specific model from the main importers, it was not possible to obtain all the desired sales volume data due to confidentiality issues. However, some reasonable data was received for refrigerators, washing machines and storage water heaters.

2.5 Baseline Analysis Methodology

The objective of the baseline analysis is to establish a basis for the cost-benefit analysis for the subsequent design of the standards and labeling scheme. The baseline defines the current average type of appliance available in the market in terms of sales numbers, energy consumption and price. This information will allow analysis of the saving potential for improving energy efficiency through standards and labeling and an assessment of associated cost implications. The analysis should ideally be based on sales weighted values for each model in an appliance category, but due to the difficulties of collecting sales data for most appliances, it is assumed that the inventory of models in the category reflects the actual sales distribution of the models. This is a fair assumption, as it is expected that most retailers will stock more models of sizes and types that are in high demand.

Assessments of the validity of this assumption have been made for refrigerators and washing machines, where two main importers dominate the market, and who have shared sales data for these appliances.

Refrigerators	Average Size (Litres)	Average Star Rating	Average Consumption kWh/year	Average Price (Nu)
Sales weighted average (Importer data)	208	2.7	233	18,773
Simple average (Retailer data)	216	2.8	251	21,846
Difference (+/-)	+3%	+3%	+4%	+16%

Table 4 Comparison of sales weighted data from importers and simple average data from retailers for refrigerators.

The sales weighted average of the data from the importer and the retailer survey shows a reasonably close fit. In terms of the size, star rating and energy consumption there are negligible discrepancies between the average values. However, for the price, there is a significant difference of 16%, which could be due to the fact that the sales data is from the year 2017, while the retail data is from 2018 and the models have increased in price. The importer may also provide a lower retail price than some of the retail outlets, which explain a higher shop price.

Washing Machines	Average Size (kg)	Average Power (W)	Average Price (Nu)
Sales weighted average (Importer data)	7.3	391	15,288
Simple average (Retailer data)	7.2	391	16,700
Difference (+/-)	-1%	0%	9%

Table 5 Comparison of sales weighted data from importers and simple average data from retailers for washing machines.

For washing machines, there is also a very close fit for the average size and average power consumption. Again the price is higher by 9% in the retailer survey compared to importer data.

This may be explained by the same reasons as for the refrigerators and may be due to a general price increase between 2017 and 2018 and some mark-up price at the retail outlets.

Based on the above comparison of sales weighted data and simple average of retail product data, it is concluded that the retail product data can be used as a basis for calculating the average values, and they fit reasonably well with the sales weighted data. The baseline analysis is therefore based on the retail product survey data and the calculation of simple averages instead of sales weighted averages.

Calculation of Baseline Energy Consumption

The objective for the baseline analysis is to determine the energy consumption of the current models in the market. For this purpose, a generic appliance is defined as the average of the models available for each appliance category. The parameters for the average model are typically:

1. Size
2. Price
3. Energy consumption. This is based on the assumed usage of the appliances and therefore, discussed in the baseline analysis for each appliance.
4. Energy rating, if a substantial number of appliances are labeled

The total national baseline energy consumption is calculated for each appliance type as the product of number of appliances imported as per the trade statistics and the energy consumption of an average appliance model as per the description above. This energy consumption defines the business as usual scenario without the standards and labeling intervention.

Calculation of Energy Savings

The energy savings are derived from the difference in energy consumption of the generic model and a similar sized model but with high energy efficiency (e.g. 5-stars). For most products it is possible to obtain product data on energy performance from energy labels on the products since many products in the market carry the Indian or Thai label. When these labels dominate the market it is possible to calculate the energy performance of the generic model and compare it with a similar sized 5-star model using the particular energy rating criteria.

For other cases where there are no labels, the energy performance of the generic model is estimated or assumed. If there is an energy rating scheme available for the product in either India or Thailand the energy saving calculation is made based on the baseline consumption of the generic model with medium efficiency i.e. 3-stars and a 5-stars equivalent model.

Calculation of Premium Cost

The premium cost is the additional cost that an equivalent energy efficient appliance will have compared to the cost of the generic model. In the cases where there is a good representation of 5-star appliances in the retailer survey database, the cost of 5-star energy efficient appliances can be derived from there. For other cases, the premium cost is based on price investigations in the Indian or Thai markets, where many of the products originates from, and where 5-star models are available.

To identify what models are available in the market, the databases of Bureau of Energy Efficiency in India (BEE) and the Electricity Generation Authority in Thailand (EGAT) are used to obtain brand and model information of 5-star products. The price information is sought from online e-stores in India and Thailand such as Amazon.in, Flipkart.com and Priceprice.com.

2.6 Baseline Study of Appliances

The following sections present the baseline study for the final 15 selected appliances. This data forms the basis for the subsequent economic analysis.

2.7 Lamps

Technology

The lamps category covers 6 main types of lamps, which are:

1. Incandescent Tungsten Lamps (bulbs)
2. Compact Fluorescent Lamps (CFL)
3. LED Lamps (LED bulbs or tubes)
4. Fluorescent Tube Light (FTL)
5. Halogen Lamps
6. Special Lamps (HID)

Figure 7 Types of lamps.

The development of the lamp market has seen a change from the usage of incandescent bulbs to CFL and now recently to LED bulbs. As the lamps provide an equal amount of light (i.e. lumens) the LED can be used instead of incandescent bulbs and save energy as their efficacy i.e. light output per Watt input is much higher than ICL or even CFL. They also have longer lifetimes. However, LEDs are priced higher and many consumers are still attracted by the low price of incandescent lamps. The lamps come in different sizes and light output levels.

FTLs are often used for general lighting purposes in homes and offices. They are provided in various lengths where 120 cm is the most common size. They are also available in various diameters, categorised in T12, T8 and T5. T12 is has the lowest efficacy and T5, the highest efficacy among the three. To operate FTLs it is necessary to install starter and ballast in the lamp fitting to ignite the lamp. The ballast consumes additional power, where electronic ballasts are more efficient than the traditional magnetic ballasts. The ballast will typically add 10-20% to the energy consumption of the lamp.

Linear lamps are also available as LED lamps. They are either provided as a complete set where lamp and fitting are assembled for direct installation, or as a LED tubes for replacement of FTL lamps in existing fittings. LED lamps do not require a starter and this must be disconnected before retrofit installations. Some LED lamp manufacturers supply the LED tubes with a dongle that can be inserted instead of the starter, which will short circuit the internal wiring in the fitting. The ballast is also not needed and should be disconnected in order to save the energy consumption of the ballast.

Halogen lamps are often used as built-in down lights or spotlights in stores, show rooms, etc. The halogen lamps have a high colour rendering index (CRI) and display colours more true than some other lamp types with a lower CRI.

Special lamps are for specific purposes. This can be floodlights, street lamps, etc. It also covers other lamp technologies such as halogen and high intensity discharge lamps e.g. high-pressure sodium, metal halide or mercury vapour lamps.

Market

Figure 8 shows the yearly imported quantities of lamps registered in the trade statistics.

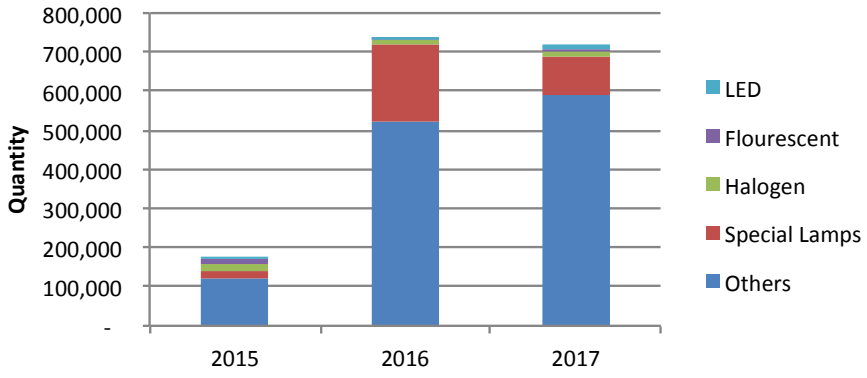


Figure 8 Import of Lamps. (Source: Bhutan Trade Statistics)

The import of lamps has varied significantly over the past 3-years. In 2015, 174,000 lamps were imported while the number increased to more than 700,000 in 2016 and 2017. Of these lamps about 14% were special lamps, so the common types of lamps were about 624,000 in 2017. For the economy baseline, analysis of the lamps is carried out based on the 2017 import figure i.e. 717,000 lamps.

Figure 9 shows that 82% of lamps registered under un-categorised lamps (registered as others). This large portion is assumed to include a variety of common lamps i.e. incandescent, CFL and perhaps also FTL, LED and halogen.

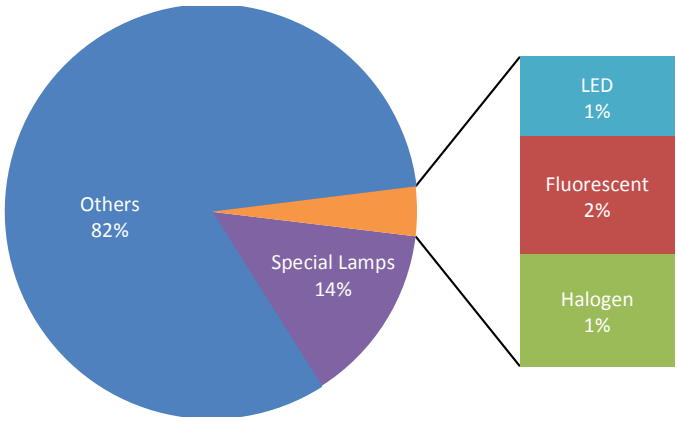


Figure 9 Distribution of lamp types imported into Bhutan in 2017. (Source: Bhutan Trade Statistics 2017)

The target for the S&L scheme are the common lamps and not special lamps, which would be metal halide, sodium lamps and special purpose lamps such as floodlights and street lamps. Thus, the total baseline quantity for the analysis is all of the above lamps excluding the special lamps.

Baseline quantity of lamps: 500,000
- ***Of which LED lamps constitute around 1%***

Current Labeling Status

The retailer survey found that 7% of the lamps in the market were labeled with the Indian energy Label and almost all lamps are imported from India (99.7%). The labels were solely found on fluorescent linear lamps and the star rating was 3-stars.

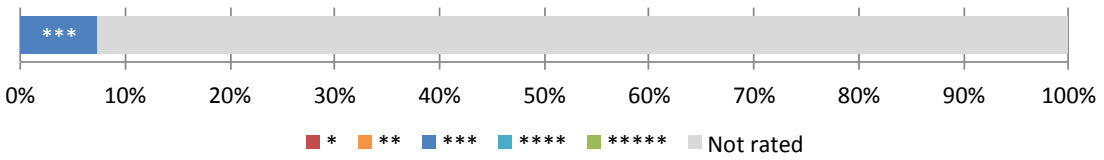


Figure 10 Lamps with energy rating. (Indian Label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 27 lamp types was registered within the 4 categories: Incandescent, CFL, FTL and LED. In the retailer survey it was found that many shops carry several brands of LEDs, while they only carry one or two brands of conventional lamps such as incandescent and FTLs, but as LED only

count for 1% of the annual imports they are excluded from the generic product definition. The generic product is therefore a mix of incandescent, FTLs and CFL products and therefore, an average of these types, which gives a 21 W lamp with an efficacy of 49 lm/W at a price of Nu. 123. This does not qualify to any stars in the Indian energy rating scheme, as the minimum efficacy must be 68 lm/W.

Item	Price [Nu]	Lumens [lm]	Power [W]	Efficacy [lm/W]	Usage [hours/year]	Energy Consumption [kWh/year]
Generic Lamp	123	1023	21	49	1,460	31

Table 6 Baseline data for lamps.

The annual energy consumption is determined by the average annual usage of lamps, excluding the LED. As there are no surveys of lamp usage in Bhutan, it is necessary to estimate the average usage. A recent study[4] carried out in India found that the average lamp usage was between 3.2-5.5 hours per day depending on the household income. The higher usage was in low-income homes, as the number of lamps was less, while high income homes had more lamps, but some were used less frequent. Based on the ratio of low, medium and high-income households in Bhutan and the usage data from India, the average usage is estimated to be about 4 hours per day.

Baseline Energy Consumption

Item	No.	Power [W]	Unit Energy Consumption [kWh/year]	Total Energy Consumption [MWh/year]
Lamps	500,000	21	31	15,330

Table 7 Baseline energy consumption of lamps

Energy Savings

The baseline energy performance of the surveyed lamps is 49 lm/W. This is the average of the lamp types available, where incandescent lamps have a low efficacy, while FTLs have higher efficacy and LEDs have the highest efficacy compared to the rest. The average efficacy of lamp types available in the Bhutanese market is shown in Figure 11.

[4] Prayas (Energy Group), Understanding the impacts of India's LED bulb programme, "UJALA", 2017

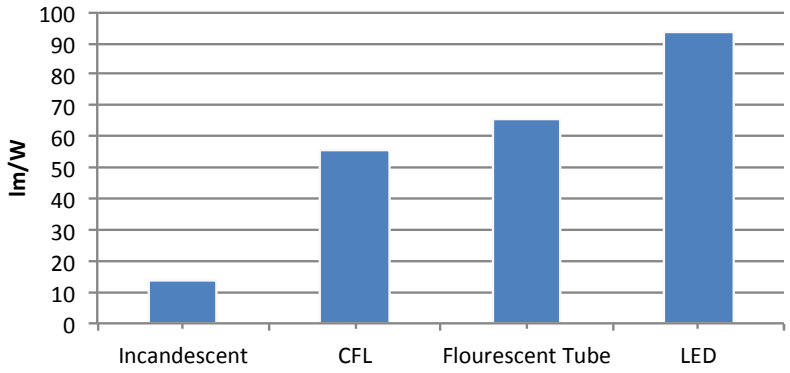


Figure 11 Efficacies of lamps in the Bhutanese market. (Source: Retailer survey 2018)

According to retailer interviews in Thimphu, there is an increasing demand for LED bulbs as they are priced at almost the same level as CFL. Due to past promotion of LEDs, more and more customers are choosing LED instead of CFL and incandescent lamps. As LED has reduced significantly in price over the past few years, and is continuing to improve quality, and performance, it is expected that this technology will continue to take up a larger market share.

The potential energy saving for lamps is based on the energy rating criteria in the Indian energy rating scheme for lamps. There are two schemes; one for FTL and another for LED. The rating criteria for the two are almost equal, so for simplicity the rating for LED is the one that is applied in the potential savings calculations.

Stars	TFL [lm/W]	LED [lm/W]
1	65	68
2	75	79
3	85	90
4	95	105
5	110	120

Potential Savings for improving the baseline level to 5-stars			
Description	Efficacy [lm/W]	Lumens [lm]	Power [W]
Baseline	49	1,023	21
5-Stars	120	1,023	8.5
		Savings	**12.5**
		%	**60%**

Table 8 Energy rating criteria in the India energy rating scheme and calculation of savings if the baseline efficacy is improved to the 5-stars level.

Comparing the lamps in the Bhutanese market with the Indian rating criteria shows that the lamps are not meeting the most energy efficient range.

Type	Range in Bhutanese Market [lm/W]	Star level
FTL	62.5 - 69	0 - 1 stars
LED	80 - 100	2- 4 stars

Table 9 Equivalent star rating for lamps in the Bhutanese market.

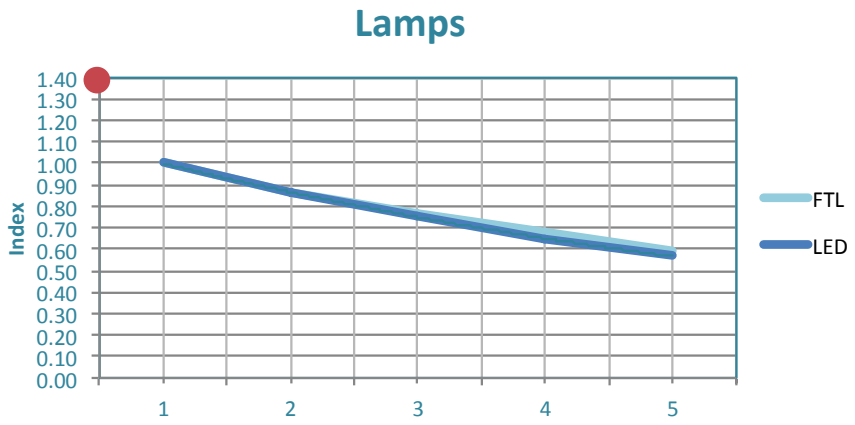


Figure 12 Energy savings according to the Indian energy rating scheme. Baseline is equivalent to 0 stars and an index 1.4, which is about 30% less efficient than the least efficient 1-star lamp and 60% less efficient than a 5-star lamp.

The total potential saving per year from fully transforming the market from the current baseline level (zero star equivalent) to 5-stars is shown below:

Description	Number	Lumens	Efficiency [Lm/W]	Power [W]	Usage [hours/year]	Energy Consumption [MWh/year]
Baseline	500,000	1,023	49	21	1,460	15,330
Potential	500,000	1,023	120	8.5	1,460	6,205
					Energy Saving	**9,125**
					Energy Saving %	**60%**

Table 10 Potential energy savings.

Cost Implications

The energy efficient lamps qualifying for 5-stars will mainly be LED lamps. The average price for the generic lamp was calculated to be Nu. 123. As there are no lamps that qualify for 5-stars registered in the retailer survey, the price for such lamp is sourced from the Indian market i.e. Nu. 280 (for a lamp with an equal lumens output as the generic lamp[5]). The price is considered reasonable when compared to prices for less efficient LED lamps of the same lumens output, which cost around Nu. 275 in Bhutan as per the retailer survey data.

[5] The 5-star lamp prices are for SYSKA and Crompton brands and are obtained from Amazon.in. Lamp prices in India are normally given by the manufacturers and stated on the packaging, which is also the price that applies in Bhutan for Indian manufactured lamps.

Description	Lumens	Price [Nu.]	Cost per lumen [Nu/lm]
Baseline	1,023	123	0.12
5-stars	1,023	281	0.27
	Premium	**158**	**0.15**
	Premium %	**+128%**	

Table 11 Premium cost for 5-stars.

The additional cost for 5-star labeled lamps compared to the baseline cost of lamps is about 128%. However, the LED lamp will have a lifetime that is 50,000 hours, where the baseline lamp will have a lifetime of about 5,000 hours, so the 5-star lamp is cheaper over the lifetime, as 10 of the baseline lamps are required over the same period.

2.8 Rice Cookers

Technology

Electrical Rice Cookers can be divided into 3 main types: 1) Un-insulated rice cooker, 2) Insulated rice cooker, and 3) Multi cooker. Common for all types is that they comprise a removable cooking bowl, where rice and water is added, and an electrical heater to steam the rice. The steaming process continues until all the water is absorbed and evaporated. A built-in thermostat detects a temperature rise above the boiling temperature when there is no more free water left. This either switches the heating off or triggers the keep-warm function at a reduced heating power. The main power consumption of the cooker is during the steaming process, which will be at the rated power consumption of the appliance, while the keep warm function will typically be at 5-10% of the rated power consumption.

The Un-insulated rice cooker is typically made in metal and has a simple outer metal sheet. The lid is a simple single layer metal sheet or glass. This type will radiate a lot of heat to the surroundings and thus more energy is required to both steaming the rice and keeping it warm.

The insulated rice cooker is made of double layer metal sheets or an outer plastic sheet. The two layers are separated by insulation or the air space is providing insulation. The lid is also insulated and has a lock mechanism to keep the lid airtight to the bowl. A pressure release valve or vent allows steam to evaporate during the cooking process. This type of cooker is consuming less energy during the cooking process as the evaporation of water is less and thus less water is used. The insulation of the cooker retains heat and significantly reduces the heat losses when the cooker is in keep-warm mode and thus less power is required to maintain the desired temperature of the rice.

The multi cooker is typically also an insulated cooker, but it has a more advanced thermostat controller where the temperature can be set at the desired level as well as a built-in timer to set the cooking time. This type may have a microcomputer, which can be programmed to start and stop at given times and may allow for cooking a variety of foods apart from only rice, including slow cooking, etc.

Figure 13 Rice cookers

Most rice cookers are equipped with a simple plate or band-heating element, while newer and more advanced models may be using induction for heating, which can provide a more even heat distribution.

Market

The officially imported number of rice cookers is compiled by the DRC, while the actual total import may be higher due to the number of appliances brought in by individuals which may or may not be declared at the point of import. However, The S&L scheme in Bhutan, will only affect the sales in the country, while appliances bought overseas will not be part of the labeling scheme.

The trade statistics aggregates all types of cookers in one category covering: other ovens, cookers, cooking plates, boiling rings, grillers and roasters. This includes rice cookers, curry cookers, induction cookers, etc.

The import of cookers was around 138,000 in 2017 and the growth in import is 12% p.a. over the past 3 years.

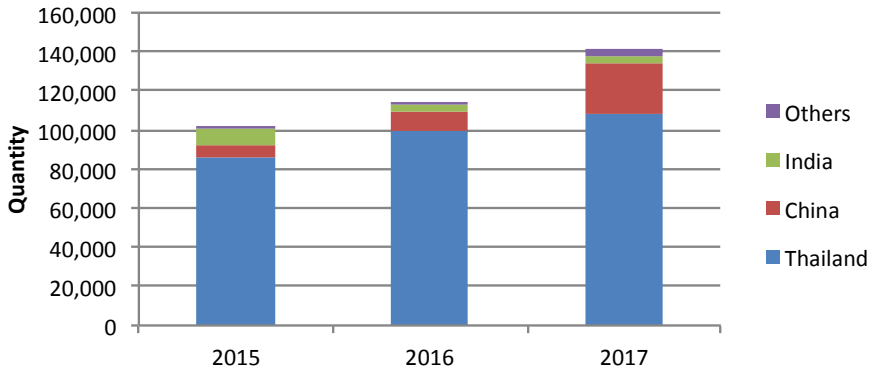


Figure 14 Import quantities of ovens and cookers. (Source: Bhutan Trade Statistics)

It is assumed that cookers take up the majority of this category and 75% of all the appliances in the category are cookers. In order to determine the share of rice cookers the total imported number is divided into rice cookers, curry cookers and induction cookers according to the ownership of these appliances, as found in the household survey in 2015. Induction cookers were not covered in the household study, so it assumed to be around 10% of the households that have an induction cooker.

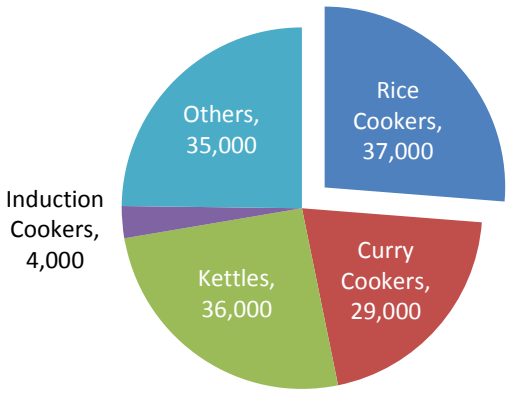


Figure 15 Share of cookers and water boilers within the trade category for others ovens in 2017. Share is based on ownership of appliances from household survey.

Baseline quantity of rice cookers: 37,000

Cookers and water boilers are imported from various countries, where Thailand is the main country of origin with about 76% of the market, followed by China with 19%. Only about 2% is imported from India. As the category of other ovens in the trade statistics is covering a broad range of appliances, the import origin of the rice cookers in the retailer survey has been analysed and compared to the trade statistics. The result shows a similar distribution of countries of origin.

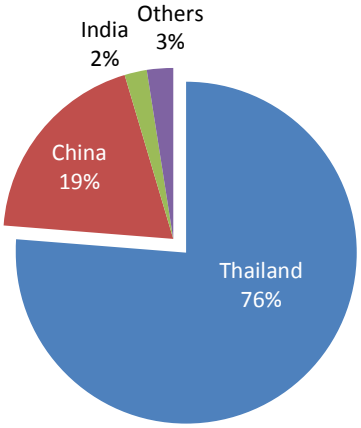


Figure 16 Import distribution for the category of other ovens (including cookers) based on the trade statistic 2017.

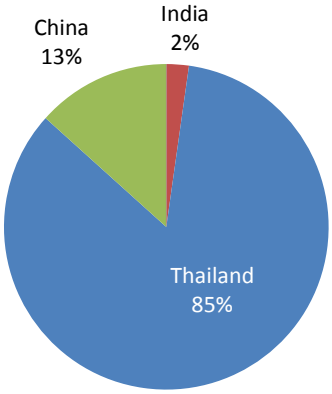


Figure 17 Import distribution of rice cookers according to the retailer survey 2018.

Current Labeling Status

The retailer survey revealed that about 13% of the rice cookers are labeled. The only label found is the Thai energy label, as there is no energy label for rice cookers in India. Although about 76% of all rice cookers in the market are from Thailand it is mainly the 5-star products that are labeled. This is due to the labeling requirement being voluntary in Thailand.

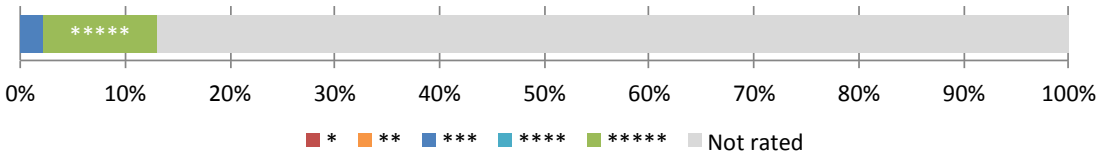


Figure 18 Rice Cookers with energy rating. (Thai label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 45 rice cookers were registered ranging from 0.3 litres to 10 litres in volume capacity.

Item	Price [Nu]	Volume [l]	Power [W]	Annual Usage [hours/year]	Energy [kWh/year]
Generic Rice Cooker	3,400	3.0	809	196	159

Table 12 Baseline data for rice cookers.

The annual energy consumption is calculated based on the usage hours assumed in the Thai energy rating standard for rice cookers, i.e., 130 hours per year.

Baseline Energy Consumption

Item	No.	Power [W]	Unit Energy Consumption [kWh/year]	Total Energy Consumption [MWh/year]
Rice Cookers	39,000	809	159	6,185

Table 13 Baseline energy consumption of rice cookers.

Energy Savings

The potential energy saving for rice cookers is based on the energy performance criteria in the Thai energy rating scheme. The test is based on the amount of energy required to cook a reference amount of rice. Efficient cookers will have a more precise thermostat, which will cut of the power when all excess water is evaporated. In addition, more insulated cookers will be able to retain the heat better and thus require less energy to achieve the temperature and also require less energy to keep the rice warm in the cooker.

As only 5-star rated rice cookers in the market carry information about the efficiency, it is assumed that the non-labeled rice cookers are equivalent to 3-stars in Thailand.

Stars	Efficiency [%]
1	-
2	-
3	76
4	81.5
5	87

Potential Power Savings for improving the baseline level to 5-star			
Description	Power Out [W]	Efficiency [%]	Power In [W]
Baseline (3-stars)	615	76%	809
5-Stars	615	87%	707
		Power Savings	**102**
		Power Savings %	**13%**

Table 14 Energy rating criteria in the Thai energy rating scheme and calculation of savings if the baseline efficacy is improved to the 5-stars level.

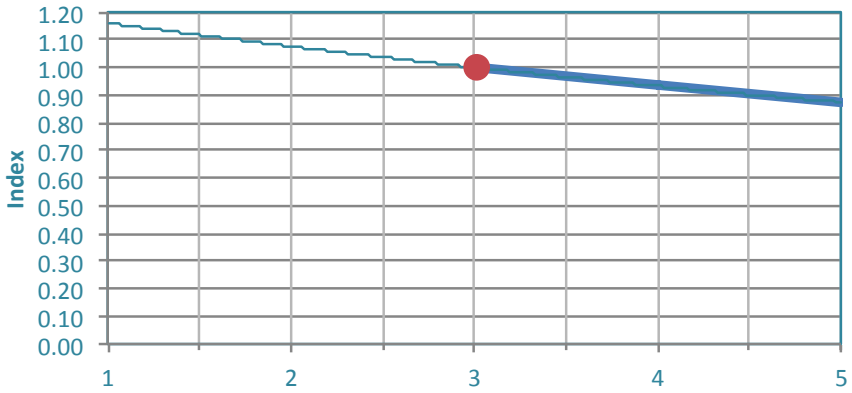


Figure 19 Energy savings according to the Indian Energy rating Scheme. Baseline is assumed to be 3-stars and an index 1.0, which is about 13% less efficient than a 5-star rice cooker.

Description	Number	Efficiency [%]	Power [W]	Usage [hours/year]	Energy Consumption [MWh/year]
Baseline	39,000	76%	809	196	6,185
Potential	39,000	87%	707	196	5,405
		Energy Saving	**780**		
		Energy Saving %	**13%**		

Table 15 Potential energy savings for 5-star rice cookers.

Cost Implications

The average price for rice cookers in the market is found to be Nu. 3,400 and the average size is 3 litre capacity. The 5-star rice cookers registered in the retailer survey is of a smaller capacity of about 1.5 litres on average. The prices are therefore compared in terms of cost per litre of capacity.

Description	Capacity [l]	Cost per litre [Nu/l]	Price [Nu]
Baseline	3.0	1,129	3,386
5-stars	3.0	1,882	5,646
		Premium	**2,260**
		Premium %	**+67%**

Table 16 Cost comparisons of baseline and 5-star rice cookers.

2.9 Water Boilers

Technology

Water boilers are used to boil water for tea or coffee making or for other purposes where boiled/hot water is required. Some models are simple water boilers that bring the water to a boil and then switch off, others are insulated in order to store hot water, and are equipped with a keep warm function a dispenser.

The most energy efficient models are insulated. The insulation reduces the heat losses to the surroundings and reduces the boiling time, as well as extends the time of keeping water warm. The most efficient use of water boilers is to boil only the amount of water required, however often more water is boiled and the excess is left in the water boiler. Well-insulated water boilers will keep this excess water warm and if a reheat is required the amount of energy consumed will be less compared to un-insulated types, where the temperature will drop faster.

Water kettle

Water boiler (dispenser)

Figure 20 Types of Water Boilers

Market

The import of water boilers into Bhutan is registered in the trade statistics in an aggregated category together with other cookers and ovens. The share of water boilers in this category is estimated from the ownership of water boilers as found in the household survey in 2015. Apart from the registered imports there may be a substantial number of water boilers, which are brought in by individuals from overseas and which are not registered. However, a Bhutan labeling scheme would have no impact on such purchases overseas.

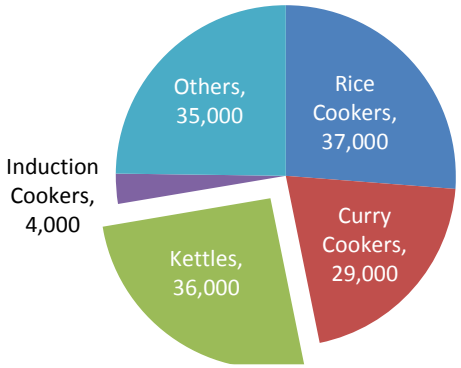


Figure 21 Import of water boilers based on the share of the category for other ovens in the trade statistics (Trade Statistics 2017 and Household Survey 2015)

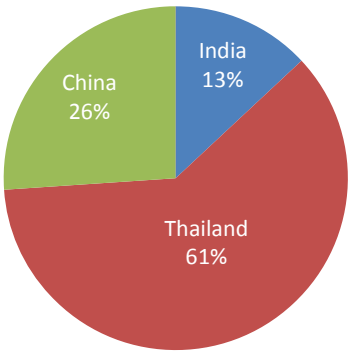


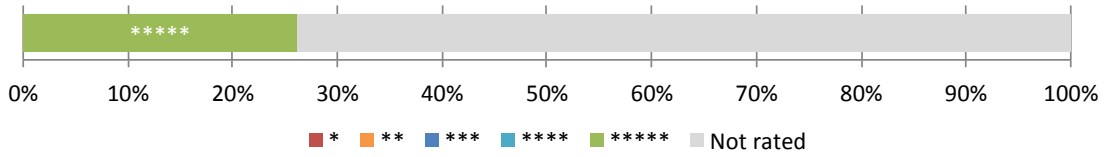
Figure 22 Import of water boilers according to the retailer survey (Source: Retailer survey)

Baseline quantity of water boilers: 36,000

A majority of the water boilers are imported from Thailand (61%), while about 26% are from China and about 13% is from India.

Current Labeling Status

Due to the major import from Thailand, some of the water boilers carry the Thai energy label. It was found that about 25% of the water boilers in the market are labeled with the Thai 5-stars label. There are no labeling of water boilers in India, and thus no labels on the products in the market.



Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 23 water boilers have been registered, ranging from 0.3 litres to 4.3 litres in volume.

Item	Price [Nu]	Volume [l]	Power [W]	Annual Usage [hours/year]	Energy [kWh/year]
Generic Water Boiler	1,680	2.5	1,017	145	147

Table 17 Baseline data for water boilers.

The annual energy consumption is determined from the energy consumption from the Thai test results. It is assumed that the usage of water boilers in Thailand and Bhutan is similar.

Baseline Energy Consumption

Item	No.	Unit Energy Consumption (kWh/year)	Total Energy Consumption (MWh/year)
Water Boiler	38,000	147	5,604

Table 18 Baseline energy consumption of water boilers.

Energy Savings

The potential energy saving from water boilers is based on the energy performance criteria in the Thai energy rating scheme. The test is based on the amount of energy required to heat water from 30°C to 90°C. As only 5-star rated water boilers and other water boilers in the market carry information about the energy efficiency, it is assumed that the non-labeled water boilers have efficiencies equivalent to 3-stars in Thailand.

Stars	Efficiency [%]
1	-
2	-
3	82
4	86
5	90

Potential Savings for improving the baseline level to 5-stars			
Description	Power Out [W]	Efficiency [%]	Power In [W]
Baseline (3-stars)	834	82%	1,017
5-Stars	834	90%	927
		Energy Saving	90
		Energy Saving %	**9%**

Table 19 Energy rating criteria in the Thai energy rating scheme and calculation of savings if the baseline efficiency is improved to the 5-star level.

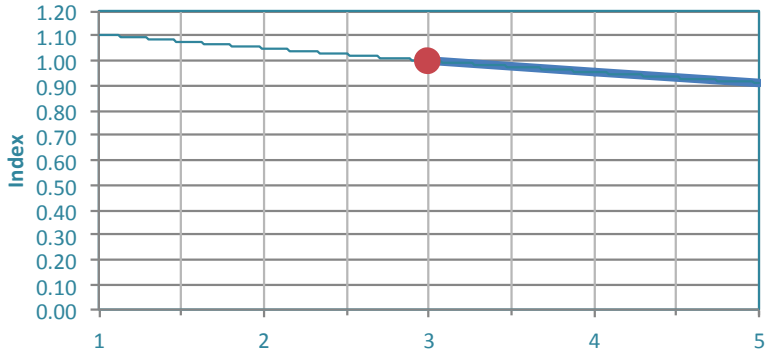


Figure 23 Energy savings according to the Thai energy rating scheme. Baseline is assumed to be 3-stars and an index 1.0, which is about 9% less efficient than a 5-star water boiler.

Cost Implications

The average price for water boilers in the market is found to be Nu. 1,680 and the average size is 2.5 litres. The retailer survey found six 5-star labeled water boilers in the capacities from 1.6 – 2.8 litres. The prices are compared in terms of average cost per litre for the 5-stars water boilers.

Description	Capacity [l]	Cost per litre [Nu/l]	Price [Nu]
Baseline	2.5	672	1,680
5-stars	2.5	752	1,879
	Premium	**80**	**199**
	Premium %	**12%**	

Table 20 Premium cost for 5-star water boilers.

2.10 Refrigerators

Technology

The most common types of refrigerators in the Bhutanese market are direct cool models and frost-free models. The direct cool model has 1 door and a freezer compartment located inside the refrigerator compartment. The cooling element is cooling the freezer compartment to about -6°C, while the refrigerator compartment is kept at around 5°C. The freezer compartment is only for ice making or keeping frozen products for a short period of time.

The frost-free model has 2 doors and two separate compartments: a freezer compartment and a refrigerator compartment. The freezer compartment is normally cooled to -18°C allowing products to freeze and longer term storage of frozen goods. The refrigerator compartment is kept at around 5°C and since the freezer compartment is separate there is no frost conditions in the refrigerator compartment. Frost-free models also include a defrost function that will assist in keeping it ice-free. The frost-free refrigerators normally use more energy than direct cool, as the freezer cools to a lower temperature and the defroster consumes additional energy.


Direct Cool (1-door)


Frost-free (2-doors

The most energy efficient models will be well insulated to minimize the heat gain from the surroundings. This means better and thicker insulation of the walls and doors, as well as a close seal between the doors and walls when closed. Also the efficiency of the compressor and the thermostat control are important. Some efficient models will have frequency inverter compressors, which can adjust more precisely to the required cooling needs.

Market

The market for refrigerators has been quite constant for the past 3 years, although there was a small drop in 2016 compared to the year before, and then an increase in 2017. The most

recent year 2017 has been chosen as baseline and the number of imported refrigerators is expected to increase over time, due to general development in the economy.

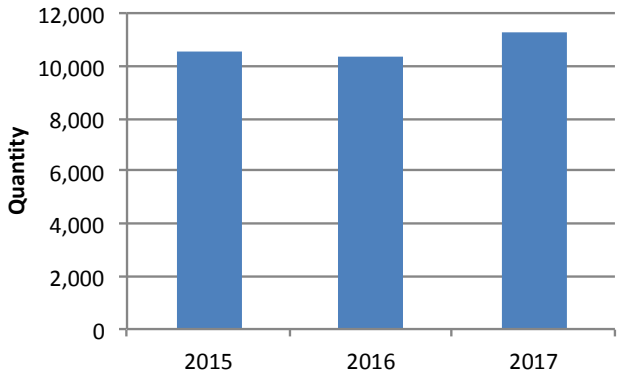


Figure 24 Import of refrigerators in the period 2015-2017. (Bhutan Trade Statistics)

Baseline quantity of refrigerators: 12,000

The vast majority of refrigerators are imported from India. Most models are manufactured in India, but some are manufactured in other countries and then distributed to Bhutan through India. According to the trade statistics 96% are imported from India, while the retailer survey found 94% from India and 6% from Thailand.

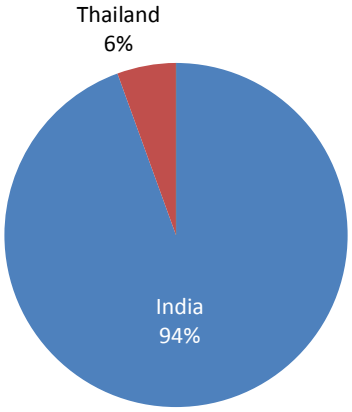


Figure 25 Import of refrigerators (Source: Retailer survey, 2018)

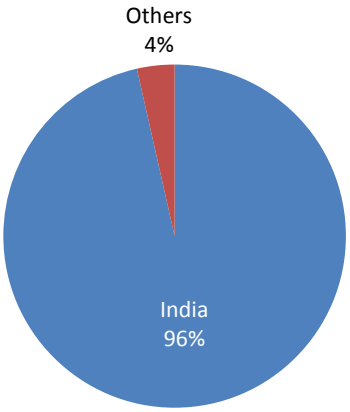


Figure 26 Import of refrigerators (Source: Bhutan Trade Statistics 2017)

Current Labeling Status

The majority of refrigerators in the market are labeled with the Indian energy label. As labeling of refrigerators is mandatory in India, the label is already affixed to the refrigerators when they are imported. The retailer survey noted that four refrigerators imported from Thailand carried the Thai energy label and were rated 5-stars, while only one was rated 5-stars under the Indian label scheme. For the 1-4 star rated refrigerators, all were imported from India.

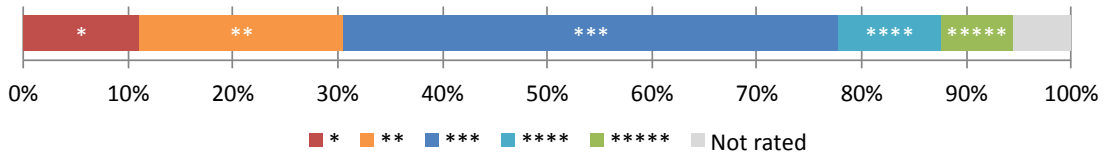


Figure 27 Refrigerators with energy label (Indian label).

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 72 refrigerators were noted, with sizes ranging from 92 litres to 350 4.3 litres in gross volume.

Item	Price [Nu]	Volume [l]	Star Rating	Energy [kWh/year]
Generic Refrigerator	21,828	216	2.8	251

Table 21 Baseline data for refrigerators.

The annual energy consumption is determined from the energy consumption provided on the energy label according to the test standard used. The star rating is based on the Indian energy rating scheme and the average of the star rating of the surveyed appliances.

Baseline Energy Consumption

The baseline energy consumption is based on the annual shipment of refrigerators and the energy consumption of the generic refrigerator as defined above.

Item	No.	Annual Energy [kWh/year]	Total Energy Consumption [MWh/year]
Refrigerators	12,000	251	3,012

Table 22 Baseline energy consumption of refrigerators.

Energy Savings

The potential energy saving is based on the savings that can be achieved by shifting from the current energy performance to a performance equal to the 5-stars level as defined in the Indian energy rating scheme.

Stars	Direct Cool Max [kWh/yr]	Frost Free Max [kWh/yr]
1	348	388
2	278	311
3	223	248
4	178	198
5	142	159

Potential Savings for improving the baseline level to 5-stars	
Description	Energy [kWh/year]
Baseline	251
5-stars	142
Energy Saving	**109**
Energy Saving %	**43%**

Table 23 Energy rating criteria in the Indian energy rating scheme for a refrigerator with an adjusted volume of 216 litres similar to the size of the generic model. Calculation of savings, if the baseline energy rating level is improved to the 5-star level.

The baseline energy rating for refrigerators in the market is about 3-stars. The potential savings is calculated as the difference in energy performance between the current baseline star rating and 5-stars. The energy efficiency in the Indian energy rating scheme is based on the tested energy consumption for refrigerators and then adjusted for the volume of the refrigerator and freezer compartment. In order to calculate the potential saving, it is necessary to apply the formulae in the test standard and calculate the maximum energy consumption that is allowed for each star level. As the generic refrigerator has a consumption of 251 kWh/year and has a rating equivalent to about 3-stars, it can be deducted that it is a direct cool model, which is also the most sold type in the market.

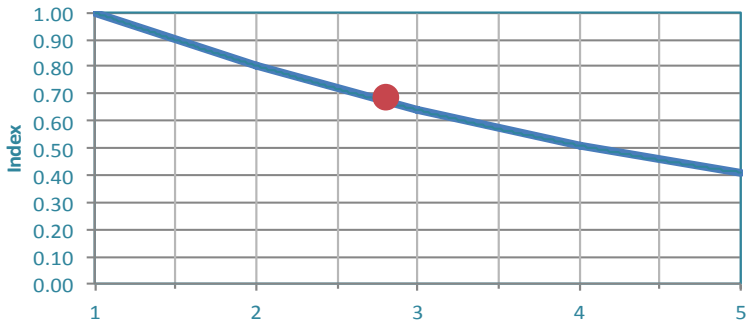


Figure 28 Energy savings according to the Indian Energy rating Scheme.

Cost Implications

The average price for refrigerators in the market is Nu. 21,800 and the average size is 216 litres. The retailer survey identified one refrigerator model, which is available in both a 3-stars and a 5-stars model, which suggested a premium cost of about 11%. However, the price premium may be higher as found in a price check of prices in India for 1-5 stars rated refrigerators. The survey included 3 models within each star band and the diagram below shows the average price per litre for the sampled refrigerators.

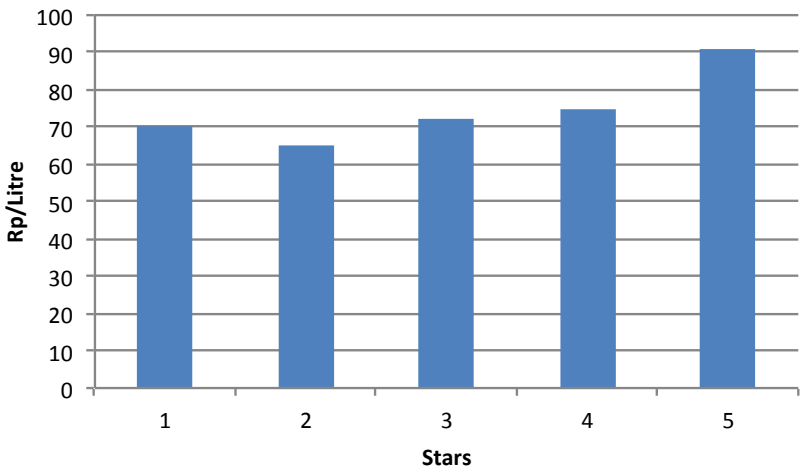


Figure 29 Price levels in India for a sample of 1-5 stars refrigerators. (Source: Amazon.in)

The Indian price levels suggest that the premium cost between a 3-stars level and 5-stars is about Rs. 20 per litre or about 30% premium. However, the cost premium for the one model in Bhutan shows about 17% premium cost. This is between 3 and 5 stars.

Description	Capacity [litre]	Price [Nu.]
3-star model	190	16,800
5-star model	190	19,600
	Premium	2,800
	Premium %	17%

Table 24 Cost comparison of 3-star and 5 star refrigerator based on actual models available in Bhutan.

Therefore, the premium cost used in the analysis is assumed to be 25%, which is the average between the premium found in India and Bhutan.

Description	Capacity [l]	Price [Nu]	Cost per litre [Nu/l]
Generic model (3-star)	216	21,828	101
5-star model equivalent	216	27,250	126
	Premium	**5,422**	**25**
	Premium %	**25%**	

Table 25 Premium cost of 5-stars refrigerators.

2.11 Curry Cookers

Technology

Curry Cookers are quite similar to rice cookers and steamers. The difference is that the curry cooker allows an adjustable temperature control between low and high heat. Some models even allow higher temperatures for frying. Simple cookers have an adjustable dial that controls the power to the heating element. Other have a thermostat and temperature setting to maintain a certain temperature of the food being prepared.

Simple Curry Cooker

Advanced Cooker with temperature control

The most energy efficient models are insulated in order to reduce the heat losses to the ambient air and thermostat to control the temperature of the foods being prepared and thus only consume the necessary amount of power that is required to maintain that temperature. Curry cookers normally have a heating element, but some newer models are equipped with induction heating element allowing a more even heat distribution.

Market

The retailer survey found 9 curry cookers and all were imported from Thailand. The number of imported curry cookers is estimated in a similar way as rice cookers, water boilers and induction cookers. As these appliances are part of the category of other ovens in the trade statistics, it is necessary to estimate the share of curry cookers. This is done based on the ownership data from the household survey from 2015.

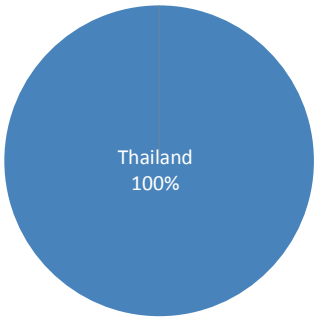


Figure 30 Import of curry cookers. (Source: Retailer survey, 2018)

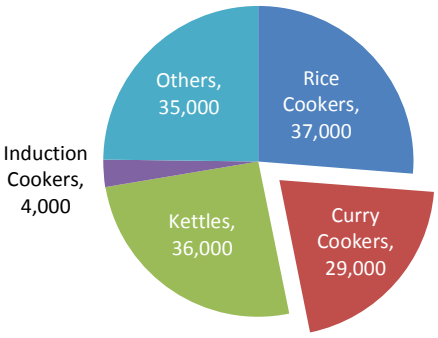


Figure 31 Estimated market shares of curry cookers. (Source: Bhutan Trade Statistics, 2017 and Household Survey 2015)

Baseline quantity of curry cookers: 29,000

Current Labeling Status

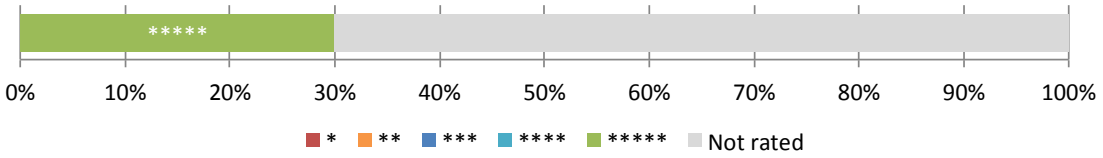


Figure 32 Curry Cookers with energy label. (Thai label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 9 curry cookers are registered, ranging from 1.1 litres to 3.5 litres in volume.

Item	Price [Nu]	Volume [l]	Power [W]	Energy [kWh/year]
Generic Curry Cooker	1,440	2.2	950	124

Table 26 Baseline data for curry cookers.

The annual energy consumption is calculated based on the usage hours assumed in the Thailand energy rating standard for curry cookers and the Thai database for curry cookers. The annual usage is 130 hours per year.

Baseline Energy Consumption

Item	No.	Power [W]	Annual Usage [hours/year]	Total Energy Consumption [MWh/Year]
Curry Cookers	30,000	950	130	3,705

Table 27 Baseline energy consumption of curry cookers.

Energy Savings

The potential energy savings for curry cookers are based on the energy performance criteria in the Thai energy rating scheme. The test measures the amount of energy required to cook a reference amount of food. More efficient cookers have a more precise thermostat, which keep the temperature stable and avoid excess heating. In addition, more insulated cookers are able to retain the heat better and thus require less energy to achieve the temperature and also require less energy to keep the food warm in the cooker.

As only 5-stars rated curry cookers in the market carry information about energy efficiency, it is assumed that the non-labeled curry cookers are equivalent to 3-stars in Thailand.

Stars	Efficiency [%]
1	68.0
2	70.5
3	73.0
4	75.5
5	78.0

Potential Savings for improving the baseline level to 5-star			
Description	Power Out [W]	Efficiency [%]	Power In [W]
Baseline (3-star)	694	73%	950
5-Star	694	78%	890
		Power Savings	**60**
		Power Savings %	**6%**

Table 28 Energy rating criteria in the Thai energy rating scheme and calculation of savings if the baseline efficacy is improved to the 5-stars level.

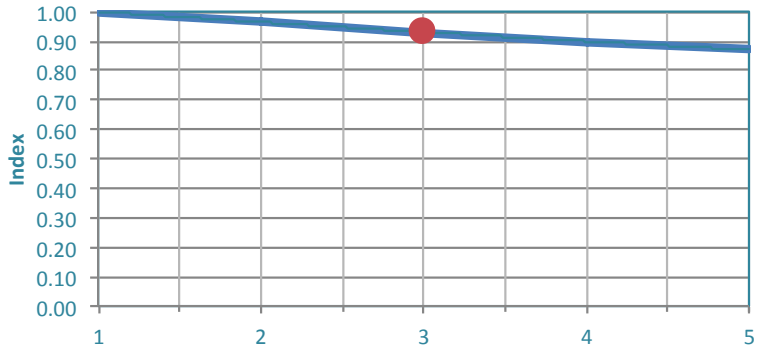


Figure 33 Energy savings according to the Thai energy rating Scheme. Baseline is assumed to be 3-stars which is index 0.93, which is about 6% less efficient than a 5-stars curry cooker, which has an index 0.8

Description	Number	Efficiency [%]	Power [W]	Usage [hours/year]	Energy Consumption [MWh/year]
Baseline	30,000	73%	950	130	3,705
Potential	30,000	78%	890	130	3,471
Energy Savings			**234 MWh/year**		
Energy Savings [%]			**6%**		

Table 29 Potential energy savings from 5-stars curry cookers.

Cost Implications

The average price for curry cookers in the market is found to be Nu. 1,440 and the average size are 2.2 litres. In order to calculate the premium cost for 5-stars curry cookers the prices are compared in terms of cost per litre of capacity.

Description	Capacity [l]	Price [Nu]	Cost per litre [Nu/l]
Baseline	2.2	1,440	653
5-stars	2.2	1,613	733
Premium		**173**	**80**
Premium %		**+12%**	

Table 30 Premium cost of 5-stars curry cookers.

2.12 Induction Cookers

Technology

Induction cookers or stoves use magnetic induction that creates an oscillating magnetic field, which heats the cooking pot placed on top. Because it heats the pot itself and does not have a mass heating element, it provides a much more efficient and direct cooking process, where less heat is transferred to the surroundings, compared to thermal conduction heaters. It also heats up and cools down quickly due to the direct magnetic induction of the cooking pot. The main energy consumption is from energizing of the electromagnetic coil and the use of cooling fan.

Single burner table top induction cooker

Multi burner built-in induction cooker

Most induction cookers available in Bhutan are the single burner, table top models. These normally have controls for the power to the coil and thus the heat generated in the pot. More advanced models have pre-sets for various food preparations and timer to automatically switch off when the desired cooking time is achieved. Induction cookers are also available in 2, 3 or 4 burner models, which are either table top or built-in types. They have similar features as the single burner types.

Market

The total import of induction cookers is roughly estimated from the total import of other ovens in the trade statistics. As the category includes rice cookers, curry cookers, ovens, etc. it is assumed that induction cookers is a very small portion of the total imports. The household survey did not register any induction cookers in 2015. This may be either because the survey did not specifically cover this technology, or that induction cookers were not widespread in Bhutanese homes during that time.

During the retailer survey it was also noted that the shops do not keep a large stock of induction cookers. Most shops will only have one or two models, and many shops do not carry induction cookers at all.

The share of induction cookers is assumed to be about 5% of the technologies in the import category for other ovens. So the total import is about 4,000 units per year. This was further cross checked with the number of registered induction cookers in the retailer survey, i.e., about 13% of the number of registered rice cookers. Therefore, this indicates that the sale may be around 4,000 - 5,000 numbers per year.

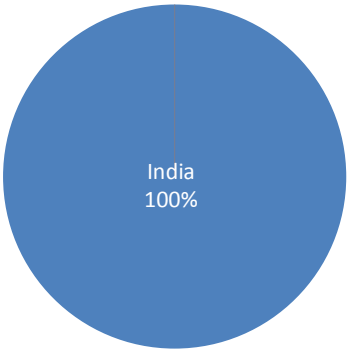


Figure 34 Import of induction cookers. (Source: Retailer survey, 2018)

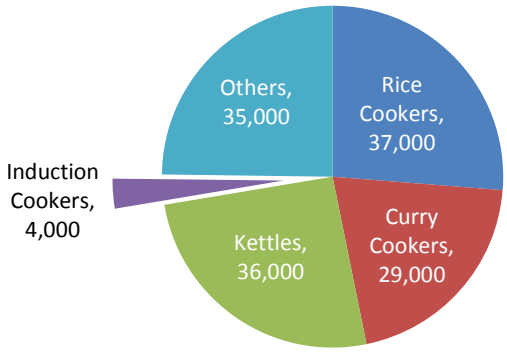


Figure 35 Estimated market shares of induction cookers. (Source: Bhutan Trade Statistics, 2017 and Household Survey 2015)

Baseline quantity of Induction Cookers: 4,000

Current Labeling Status

All induction cookers registered in the retailer survey were from India where energy labeling scheme for the technology has not been developed yet. Therefore, none of the cookers had energy labels.

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of only 6 induction cookers were noted. The reason for the small number is that many shops do not have any induction cookers in stock and for those who have cookers in stock, they only have 1 or 2 models. All the cookers were single burners, ranging from 1500-2100 W of power input.

Item	Price [Nu]	Power [W]	Usage [hrs/year]	Energy [kWh/year]
Generic Induction Cooker	3,640	1,800	130	234

Table 31 Baseline data for induction cookers.

Baseline Energy Consumption

Item	No.	Power [W]	Annual Usage [hours/year]	Total Energy Consumption [MWh/Year]
Induction Cookers	4,000	1,800	130	936

Table 32 Baseline energy consumption of induction cookers.

Energy Savings

The potential energy saving for induction cookers are based on the energy performance criteria in the Thai energy-rating scheme. The test is based on measuring the amount of energy required to cook a reference amount of food. More efficient cookers will have a more precise thermostat, which will keep the temperature stable and avoid excess heating. Also the cooling fan can be more efficient and require less energy to keep the induction coil cool.

As none of the sampled induction cookers were labeled, it is assumed that the average rating is 3-stars. The Thai rating scheme only comprises ratings for 3, 4 and 5 stars.

Stars	Efficiency [%]
1	-
2	-
3	62
4	73.5
5	85

Potential Savings for improving the baseline level to 5-stars			
Description	Power Out [W]	Efficiency [%]	Power In [W]
Baseline (3-stars)	1,116	62%	1,800
5-Stars	1,116	85%	1,313
		Power Savings	**487**
		Power Savings %	**27%**

Table 33 Energy rating criteria in the Thai energy rating scheme and calculation of savings if the baseline efficiency is improved to the 5-stars level.

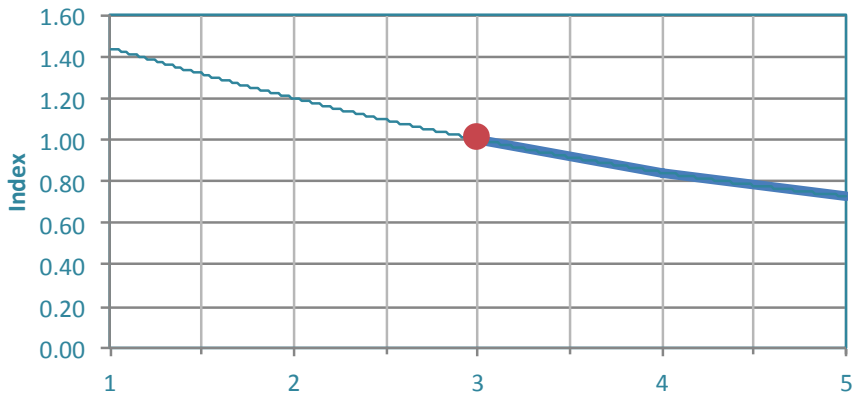


Figure 36 Energy savings according to the Thai Energy rating Scheme. Baseline is assumed to be 3-stars which is index 1.0, which is about 6% less efficient than a 5-stars induction cooker, which has an index 0.73.

Description	Number	Efficiency [%]	Power [W]	Usage [hours/year]	Energy Consumption [MWh/year]
Baseline	4,000	62%	1,800	130	936
Potential	4,000	85%	1,313	130	683
		Energy Savings	**253 MWh/year**		
		Energy Savings [%]	**27%**		

Table 34 Potential energy savings for 5-stars induction cookers.

Cost Implications

The average price for induction cookers in the market is Nu. 1,440. The price premium for a 5-stars induction cooker cannot be determined, as the retailer survey did not register any 5-stars labeled induction cookers. The premium cost is instead assumed to be similar to the premium for 5-star water boilers and curry cookers, which was 12%

Description	Price [Nu.]
Baseline	3,640
5-stars	4,077
Premium	**437**
Premium %	**+12%**

Table 35 cost comparisons of baseline and 5-stars induction cookers (Based on premium cost for water boilers and curry cookers).

2.13 Televisions

Technology

CRT TV

LED or LCD TV

The television technology has changed drastically in recent years. Today, LED TVs are the most common type, which uses less energy to display the picture compared to old cathode ray tube (CRT) televisions. On the other hand, the screen sizes have increased and where 32 inch was considered a large screen size for CRT TVs, it is now common to see screen sizes of 40 to 60 inches or larger. TVs use electricity for lighting up the screen, amplifying sound, etc. The consumption depends mostly on the brightness of the picture and the volume of sound. In addition, most TVs are not completely turned off, leading to consumption of electricity on stand-by mode.

Most TVs sold in Bhutan are the LED type. However, a few

CRT TVs are still available in the market, but it is expected that these are phased out soon. Other technologies such as LCD and plasma screens were popular until recently, but as the LED screens have reduced in price, this technology is currently dominating the market.

Market

The import of televisions in the Country has been declining over the years. The reason for the decline is unknown, but one plausible explanation could be that TVs are being bought overseas and brought into the country by individuals, which is not captured by the trade statistics.

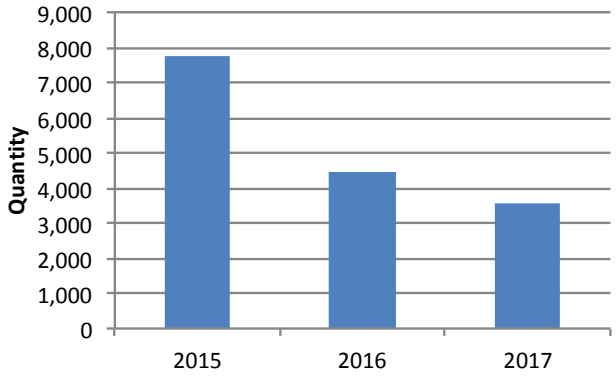


Figure 37 Import of TVs over the period 2015-2017. (Bhutan Trade Statistics, 2017)

The baseline number of TVs is set at the 2017 level, as this is the most recent year.

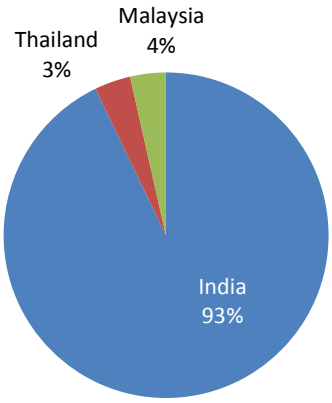


Figure 38 Import countries as per the survey. (Retailer survey, 2018)

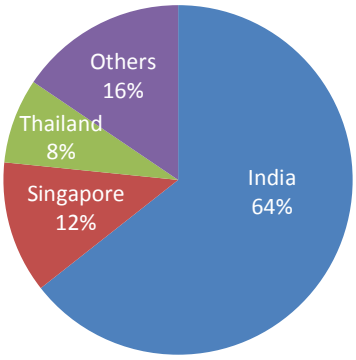


Figure 39 Import of TVs as per the trade statistics (Bhutan Trade Statistics 2017)

The major share of imports is from India with 64% of the total import of TVs according to the trade statistics while the survey indicated that 93% of TVs were from India.

Baseline quantity of Televisions: 3,000

Current Labeling Status

India has a mandatory energy labeling scheme for TVs and thus many TVs in the market are labeled with the Indian energy label: A total of 53% of all TVs in the survey was found to be labeled with the Indian energy star label.

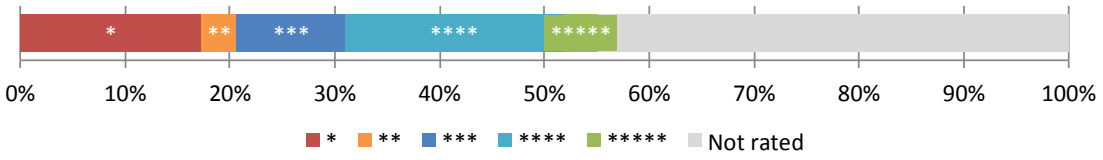


Figure 40 Televisions with energy label. (Indian label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 29 TVs were recorded during the survey, which included TVs ranging from 14 - 55 inches in screen size. It was found that 4 out of the 29 TVs were CRT, while 25 were LED.

Item	Price [Nu]	Screen Size [in]	Power [W]	Star Rating [India]	Energy [kWh/year]
Generic TV	22,268	29	63	2.9	66

Table 36 Baseline data for televisions.

The annual energy consumption is determined from TVs recorded in the retailer survey based on the average consumption stated on the energy label. The annual energy consumption on the Indian energy label is based on an Indian test standard, which estimates that the daily energy consumption is based on 6 hours in “on” mode and 12 hours in “stand-by” mode and the remaining 6 hours the TV is considered “switched off”. This usage of TVs in Bhutan is expected to be similar to the usage in India.

Baseline Energy Consumption

Item	No.	Unit Energy Consumption [kWh/year]	Total Energy Consumption (MWh/year)
Televisions	3,000	66	198

Table 37 Baseline energy consumption for televisions.

Energy Savings

The potential energy saving for TVs is calculated as the difference between the energy consumption of the generic TV above and the energy consumption of a similar sized 5-star rated TV in the Indian energy rating scheme.

Stars	Energy Consumption Of LED TV [kWh/year]
1	74
2	68
3	61
4	55
5	48

Potential Savings for improving the baseline level to 5-stars LED TV	
Description	Energy Consumption [kWh/year]
Baseline	66
5-Stars	48
Energy Savings	**18**
Energy Savings %	**27%**

Table 38 Energy rating criteria in the Indian energy rating scheme for a 29-inch LED TV, and calculation of savings if the baseline efficiency is improved from generic 1.8-stars level to 5-stars level of LED TV.

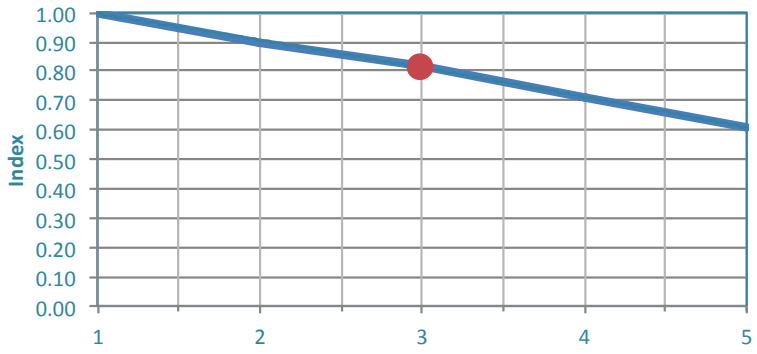


Figure 41 Energy savings according to the Indian Energy rating Scheme. Baseline is estimated to be 1-star.

Description	Number	Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	3,000	66	198
Potential	3,000	48	144
		Energy Savings	**54**
		Energy Savings %	**27%**

Table 39 Potential energy savings for 5-star televisions.

Cost Implications

The average price for the 29-inch TV is calculated based on the prices of those 5-star rated in the retailer survey.

Description	Unitary Price [Nu/inch]	Price [Nu]
Baseline	731	21,197
5-stars	1,012	29,349
Premium	**253**	**8,152**
Premium %	**+32%**	

Table 40 Cost comparisons of baseline and 5-stars TV of 29-inches screen size.

2.14 Washing Machines

Technology

Washing machines in the market are mainly top loaded, cold-water types. These appliances consume electricity for water pumping and the rotation of the drum in washing and spinning cycles. Some models are fully automatic, where washing and spinning is done in the same drum. Others are semi-automatic, where washing is done in one drum and spinning is done in another.

The energy consumption depends on the washing programme, which determines the soaking, washing, rinsing and spinning processes. Some models have heaters installed to raise the water temperature up to 90°C depending on the requirements for the laundry. This consumes additional energy. However hot water models are not common in the Bhutanese market.

Fully automatic top load

Semi-automatic top load

Fully automatic hot water, front load

Market

The market for washing machines has increased over the years. In the past three years the market grew by about 15% p.a.

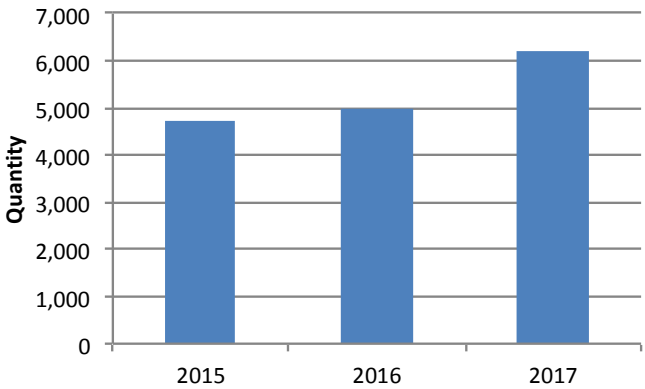


Figure 42 Import of washing machines in the period 2015-2017 (Source: Bhutan Trade Statistics)

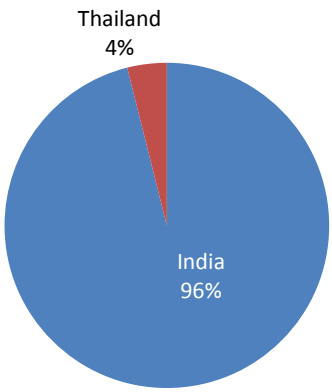


Figure 43 Import share of washing machines according to the retailer survey. (Source: Retailer survey 2018)

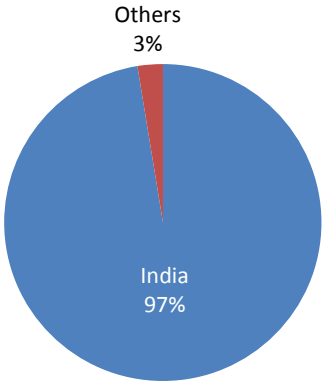


Figure 44 Import share of washing machines according to the trade statistics. (Source: Bhutan Trade Statistics 2017)

Almost all washing machines are imported from India.

Baseline quantity of Washing Machines: 6,000

Current Labeling Status

Out of the 51 washing machines recorded in the retailer survey, only two were labeled. The label was the voluntary Thai label. There were no energy labels on the machines imported from India.

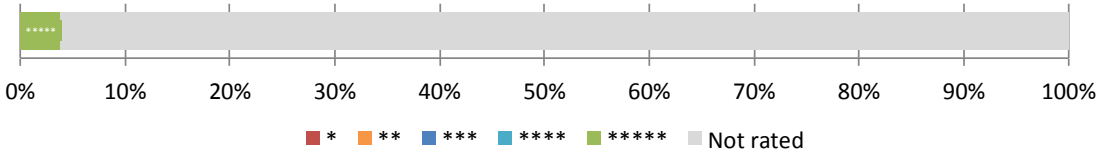


Figure 45 Washing machines with energy label. (Thai label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. 51 washing machines were recorded, ranging from 6.0 kg to 9.5 kg capacity.

Item	Price [Nu]	Capacity [kg]	Power [W]	Usage [hours/year]	Energy [kWh/year]
Generic Washing Machine	16,700	7.2	391	105	41

Table 41 Baseline data for washing machines.

The annual energy consumption is determined from the usage of the machine. The annual number of assumed washes varies from household to household. The annual energy

consumption calculation in the Indian standard is based on 317 washes, while the Thailand standard assumes 423 washes per year. In the EU the EN 60456 standard prescribes 220 cycles per year, while Australia and New Zealand assumes 1 wash per day i.e. 365 cycles per year[6].

The annual number of washes is based on the Indian test standard as this is about the average of the various standards used internationally. The machine consumes the highest amount of power for the wash and spin cycle, which is determined to be 20 min. This gives a total of 105 hours of operation at the highest power.

Baseline Energy Consumption

Item	No.	Power [W]	Unit Energy Consumption [kWh/year]	Total Energy Consumption [MWh/year]
Washing Machines	6,000	391	41	246

Table 42 Baseline energy consumption for washing machines.

Energy Savings

The potential energy savings for washing machines are based on the energy performance criteria in the suspended Indian energy rating scheme. Although it is not presently enforced it still provides a basis for assessment of the energy performance of washing machines

The energy rating is separate for semi-automatic machines and fully automatic machines. The data below is based on the fully automatic energy rating criteria.

Stars	Energy Consumption [kWh/kg]
1	0.0186
2	0.0169
3	0.0154
4	0.0140
5	0.0126

Potential Savings for improving the baseline level to 5-stars			
Description	Capacity [kg]	Energy Consumption [kWh/kg]	Energy Consumption[7] [kWh/year]
Baseline	7.2	0.0180	41
5-stars	7.2	0.0126	29
		Energy Savings	**12**
		Energy Savings %	**30%**

Table 43 Energy rating criteria in the Indian energy rating scheme, and calculation of savings if the baseline efficiency is improved to the 5-stars level.

[6] AS/NZS 2040

[7] Annual energy consumption is calculated based on 317 washes per annum as per the Indian test procedure.

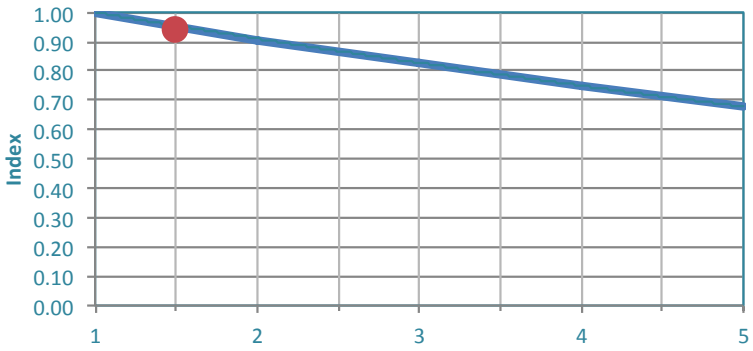


Figure 46 Energy savings according to the Indian energy rating scheme. Baseline is estimated to be 1-2 stars.

Description	No.	Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	6,000	41	246
Potential	6,000	29	173
		Energy Savings	**73**
		Energy Savings %	**30%**

Table 44 Potential energy savings for 5-stars washing machines.

Cost Implications

The price for 5-stars washing machines cannot be determined from the retailer survey or the Indian market, as they are not labeled and not possible to identify. As the retailer survey includes one fully automatic machine, which was rated 5-stars in Thailand, this machine has been used as an indication for the price of a 5-star washing machine. This is a rough assumption, as the 5-stars in the Thailand rating scheme does not equal 5-stars in the Indian rating scheme. However, as it can be seen below, the premium cost of 23% seems to be a plausible premium.

Description	Unit Price [Nu/kg]	Price [Nu]
Baseline	2,306	16,700
5-star	2,828	20,478
Premium	**618**	**3,778**
Premium %	**+23%**	

Table 45 Cost comparison of baseline and 5-stars washing machine (based on the Thai energy rating scheme).

2.15 Room Heaters

Technology

Electrical room heaters come in many different forms and use various technologies. Common for all is that amount of electricity consumed is almost fully converted into heat.

Convector heater

Oil-filled heater

Fan heater

Infrared heater

For space heating, where the aim is to bring the room temperature to a desired level, the convector heater or oil-filled heater are most appropriate. They work by heating the air and induce a natural airflow over the heating element (convection). The fan heaters or infrared heaters are most suitable to heating a person or small group of people. These types of heaters direct heat to a targeted area, but are usually not suitable for heating up the whole room.

Energy efficiency for electrical room heaters is close to 100% as most of the electricity input is converted into heat and the loss if only for a small portion is mainly due to the use of fan, if the heater has built-in fan. However, control automatics such as electronic thermostats instead of mechanical thermostats can improve the overall efficiency. Mechanical thermostats may have a tolerance of 4-5°C, whereas electronic thermostats are down to 1-2°C, and thus providing less temperature variations in the room. Possibilities to programme the heater can also save energy, as it can allow for automatic reduction of room temperature at night or when windows are being opened for ventilation, etc.

Although room heaters are efficient in itself for utilizing the electricity input for heat generation, use of heat pumps can improve the efficiency since heat pumps are able to generate about 3-5 times heat output of the electricity input, due to the utilization of heat in the outside air. Therefore, for a permanent room heating solution, heat pumps are superior to electrical heaters in terms of energy efficiency.

Market

The import of room heaters has varied over the past three years. More than 20,000 heaters were imported in 2015, and only about half of that quantity was imported in 2017. The variation may be caused by specific building projects that require heaters such as hotels,

institutions, etc., where larger quantities are imported for these projects. The climate also affects the sale of heaters: If winters are colder than normal, there will be an increase the sale of heaters.

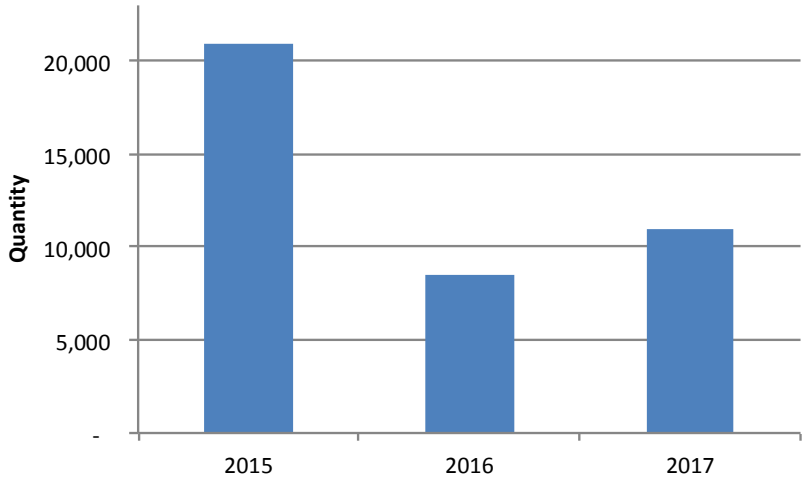


Figure 47 Import of electrical room heaters in the period 2015-2017. (Source: Bhutan Trade Statistics)

The origin of heaters is mainly China and India. Only 9 models were found in the retailer survey and they were imported from a number of countries, while the trade statistics state 80% import from China.

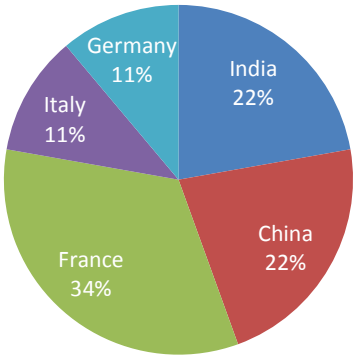


Figure 48 Import of electrical room heaters according to the retailer survey. (Source: Retailer survey 2018)

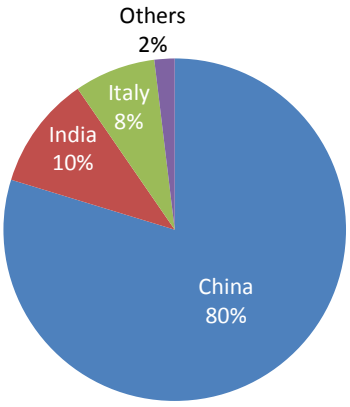


Figure 49 Import of electrical room heaters according to the trade statistics. (Source: Bhutan Trade Statistics 2017)

Baseline quantity of Room Heaters: 11,000

Current Labeling Status

The retailer survey did not find any energy labels on any of the electrical room heaters. Most countries, including India does not have labels for room heaters. Only the EU has some labeling of heating technologies, such as boilers and heat pumps.

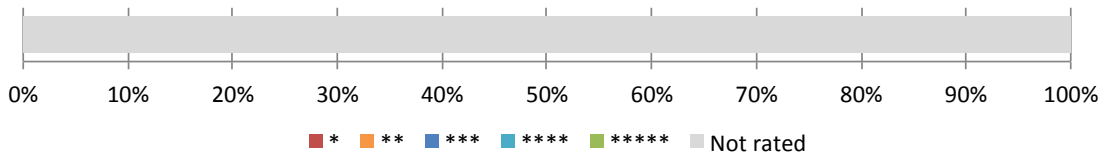


Figure 50 Room heaters with energy label. (No label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey, which noted a total of 9 room heater models, ranging from 1,200 W to 2,000 W in power rating.

Item	Price [Nu]	Power [W]	Annual Usage [hours/year]	Energy [kWh/year]
Generic Room Heater	5,150	1,963	365	716

Table 46 Baseline data for electrical room heaters.

The annual energy consumption is based on an assumption that the heater is operated 2 hours per day at full load. As the heater will mainly be used in the cold winter months, this equals to 365 hours per year. A thermostat typically controls heaters, so the heater will turn on and off depending on the room temperature. When the desired room temperature is achieved the heater will operate in short cycles to maintain the room temperature. The 2-hours per day in the heating season is the sum of these operating cycles.

Baseline Energy Consumption

Item	No.	Energy [kWh/year]	Total Energy Consumption [MWh/year]
Room Heaters	11,000	716	7,881

Table 47 Baseline energy consumption for electrical room heaters.

Energy Savings

The energy efficiency of electrical room heaters is high in terms of converting electricity to heat and most models will have an energy efficiency ratio (ratio between heat output and electricity input) close to 1. As there are no energy rating schemes available for electrical room heaters, and the efficiency of the current appliances in the market is unknown, it is difficult to assess the impact of energy rating.

Alternatively, a calculation is made for using heat pumps or reversible heat pumps instead of electrical room heaters. Heat pumps use the heat of the outdoor air to generate useful heating indoor and thus it provides higher heat output than power input.

The generic model is assumed to have an EER of 1, which means 1 W of power provides 1 W of heating. The table 48 shows the data for the energy rating of air conditioners in India. The EER is for cooling, but the EER for heating is similar or higher for reversible heat pumps, and therefore, taken as the reference.

Stars	EER
1	3.1
2	3.3
3	3.5
4	4.0
5	4.5

Potential Savings for improving the baseline level to 5-star		
Description	EER [W/W]	Energy Consumption [kWh/year]
Baseline	1.0	716
5 Star	4.5	159
Energy Savings	**4.5**	**557**
Energy Savings %	**78%**	

Table 48 Energy rating criteria in the Indian energy rating scheme for air conditioners, and calculation of savings if the baseline efficiency is improved to the 5-stars level for reversible heat pumps.

Description	Number	Unit Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	11,000	716	7,881
Potential	11,000	159	1,749
		Energy Savings	**6,132**
		Energy Savings %	**78%**

Table 49 Potential energy savings from 5-stars heat pumps compared to baseline electrical room heaters.

It can be seen that very high energy savings can be achieved by using reversible heat pumps instead of conventional electrical room heaters.

Cost Implications

The average price for the 5-stars reversible heat pumps is calculated based on the average price for the surveyed Indian 5-stars reversible heat pumps.

Description	Heating Capacity [W_h]	Unit Price [Nu/W_c]	Price [Nu]
Baseline	1,963	2.6	5,144
5-stars	1,963	9.5	18,650
	Premium	**6.9**	**13,510**
	Premium %	**+263%**	**+263%**

Table 50 Cost comparison of baseline and 5 star reversible heat pumps.

The cost implications are very high; as reversible heat pumps are much more expensive than electrical room heaters. Heat pumps often come in higher capacities, which will replace two or more electrical room heaters, as heat pumps can heat up larger room areas than a radiator heater. Worth noting is the fact that the reversible heat pump can operate as both heater in the winter and air conditioner in the summer and is therefore dual purpose.

2.16 Microwave Ovens

Technology

The microwave oven eases the process of reheating food and can also be used to prepare various dishes. There are two main types of microwave ovens. The solo microwave oven uses electro-magnetic radiation in the magnetron tube to heat the food. This oven can only heat the food, but not roast or bake, as it does not generate the Maillard reactions in the food that gives it the crust. The convection microwave oven is a combination of a microwave oven and a conventional oven with electrical heating elements. This oven can provide the high temperature infrared radiation that is required for roasting and baking.

Generation of microwaves consumes a high amount of power and require cooling of the magnetron tube by a cooling fan. It also consumes energy for the turntable, lamp, etc.

Solo microwave oven

Convection microwave oven

Market

The import of microwave ovens is relatively small and have been declining over the past 3 years. One of the reasons for the decline may be that individuals purchase the appliance overseas and bring it in as a personal import. In this way the import may not be registered in the trade statistics.

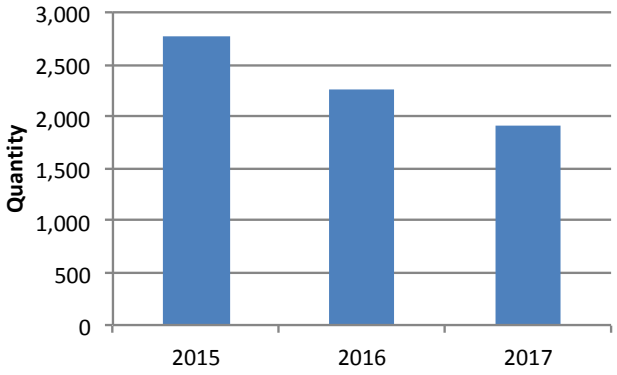


Figure 51 Import of microwave ovens in the period 2015-2017. (Source: Bhutan Trade Statistics)

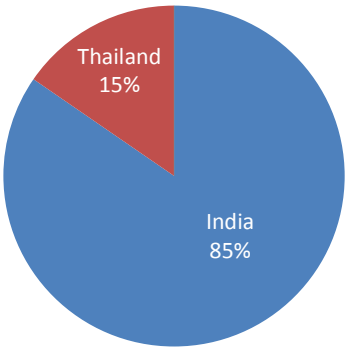


Figure 52 Import share of microwave ovens according to the retailer survey (Source: Retailer survey 2018)

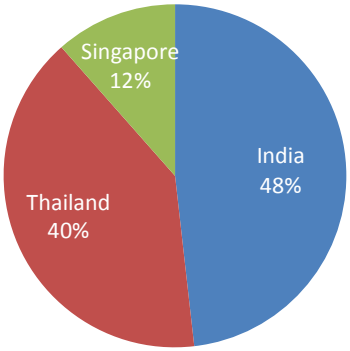


Figure 53 Import share of microwave ovens according to the trade statistics (Source: Bhutan Trade Statistics 2017)

Baseline quantity of water microwave ovens: 2,000

Current Labeling Status

None of the microwave ovens covered in the retailer survey were labeled. Although a number of models come from Thailand where there is a voluntary labeling scheme for microwave ovens, none of the models from Thailand were labeled.

Generic Product Definition

The generic product definition is based on the findings from the retailer survey, which noted 14 models of microwave ovens ranging from 700 W to 1800 W power rating.

Item	Price [Nu]	Power [W]	Usage [hours/year]	Energy [kWh/year]
Generic Microwave Oven	8,576	1,050	91	96

Table 51 Baseline data for microwave ovens.

The annual energy consumption is based on an assumption that the microwave oven is used 15 minutes per day on average. There are no references given in the Thai energy rating scheme for microwave ovens, as the label does not state the annual consumption.

Baseline Energy Consumption

Item	No.	Power [W]	Annual Usage [hours/year]	Total Energy Consumption (MWh/year)
Microwave Ovens	2,000	1,050	91	192

Table 52 Baseline energy consumption for microwave ovens.

Energy Savings

The potential energy savings for microwave ovens are based on the energy performance criteria in the Thai energy rating scheme. The energy rating only provides the thresholds for 3, 4 and 5-stars and is based on a test of the energy efficiency of the appliance. As there is no information about the energy efficiency of the surveyed ovens, it is assumed that the baseline efficiency is equivalent to 3-stars, which is lowest performance rating in the Thai energy labeling scheme.

Stars	Energy Efficiency [%]
1	-
2	-
3	52
4	55
5	59

Potential Savings for improving the baseline level to 5-star		
Description	Efficiency [%]	Energy Consumption [kWh/year]
Baseline	52%	96
5-stars	59%	85
	Energy Savings	**11**
	Energy Savings %	**12%**

Table 53 Energy rating criteria in the Thai energy rating scheme, and calculation of savings if the baseline efficiency is improved to the 5-stars levels.

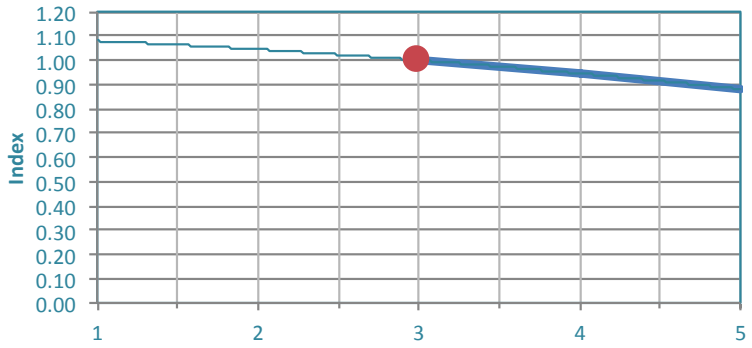


Figure 54 Energy savings according to the Thai Energy rating Scheme. Baseline is assumed to be 3-stars.

Description	Number	Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	2,000	96	192
Potential	2,000	85	169
		Energy Savings	**23**
		Energy Savings %	**12%**

Table 54 Potential energy saving for 5-stars microwave ovens.

Cost Implications

The price for 5-stars microwave ovens cannot be determined from the retailer survey, as they are not labeled. Instead a search for 5-star labeled microwave ovens in the Thai market has been used as a price basis for a 5-stars microwave oven[8].

Description	Unit Price [Nu/W]	Price [Nu.]
Baseline	1	8,576
5-star	1.5	9,101
Premium	**0.5**	**525**
Premium %	**+50%**	

Table 55 Cost comparisons of baseline and 5-stars microwave oven.

[8] Average price is based on price information for seven 5-star microwave ovens have been found from internet search on the following addresses: http://labelno5.egat.co.th and http://th.priceprice.com

2.17 Storage Water Heaters (Geysers)

Technology

Storage water heaters or geysers provide domestic hot water for showers, washing, etc. It heats the water and also stores it in order to provide instant hot water supply when needed. Electric water heaters use an electric heating element to raise the temperature from the incoming temperature level to the desired level. The temperature is preferably above 55°C in order to avoid bacteria growth. The higher the temperature the more heat is stored. Therefore, the user can get more supply of warm water as the hot water from the tank is mixed with cold water in the mixer tap to the desired temperature level e.g. 30-40°C for showers.

The amount of energy used to raise the water temperature is about the same for all models, whereas the heat losses depend on the ambient temperature, insulation of the storage tank and the thermostats accuracy. Energy efficient storage water heaters are well insulated and controlled in order to ensure low electricity consumption for compensating for the heat losses.

Storage water heaters

Market

The import data for storage water heaters are combined with instantaneous water heaters, which do not have a storage tank. 31,400 geysers were imported in 2017.

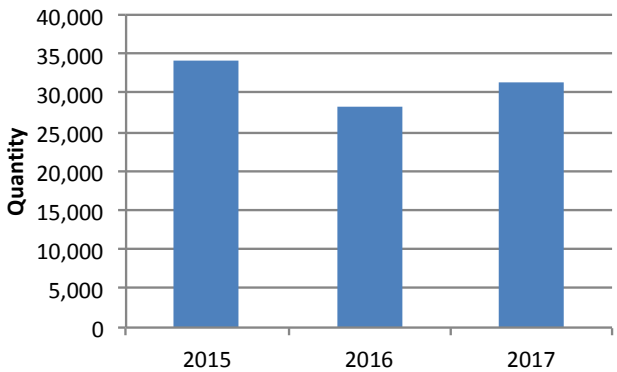


Figure 55 Import of storage water heaters in the period 2015-2017. (Source: Bhutan Trade Statistics 2017)

According to the trade statistics, the origin of water heaters is mainly India, China and Thailand. However, the retailer survey found storage water heaters only from India and France. The reason for the difference may be that the heaters imported from China and Thailand are mainly instantaneous heaters, while the ones from India and France are storage water heater.

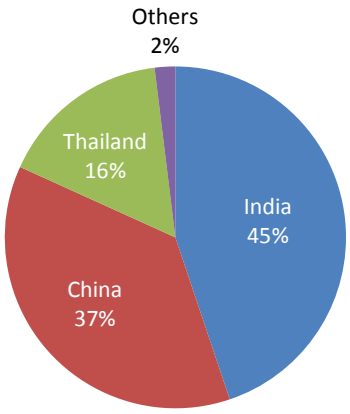


Figure 56 Import shares according to the trade statistics (Source: Bhutan Trade Statistics 2017)

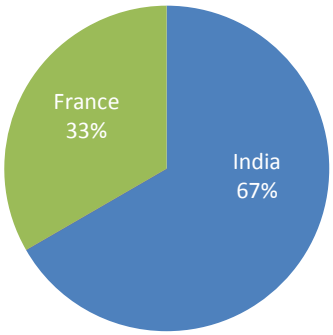


Figure 57 Import shares according to the retailer survey (Source: Retailer survey 2018)

The retailer survey also revealed that two major importers only sold around 2500 units in 2017. In addition, the household survey found that about 45% of all households have storage water heaters. Assuming that the water heater has a lifetime of about 10 years, the annual sale should be around 15,000 - 20,000 units per year. Excluding imports from Thailand and China, 16,600 storage water heaters were imported in 2017. Taking these factors into consideration, the baseline is estimated to be the 16,600 and the main country of origin is India.

Baseline quantity of water storage water heaters: 17,000

Current Labeling Status

All the imported geysers from India are labeled, as energy labeling is mandatory in India for geysers, which means more than 60% of the storage water heaters surveyed are labeled. About 25% of the surveyed water heaters were 5-stars rated and therefore highly energy efficient as shown figure below:

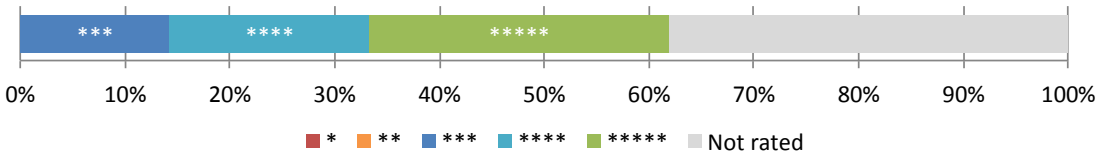


Figure 58 Storage water heaters with energy label. (Indian label)

The energy performance is based on the standing losses per day expressed by kWh/day required to offset the heat losses. It does not cover the energy required for heating the water for use, which will vary according to the hot water consumption of the user. The standing losses gives a more precise value for the energy efficiency, but cannot be used to estimate the actual electricity consumption of the heater.

Generic Product Definition

The generic product definition is based on the findings from the retailer survey, which found a total of 21 models of storage water heaters ranging from 6 litres to 100 litres storage capacity.

Item	Price [Nu]	Volume [l]	Power [W]	Efficiency [kWh/day]	Annual Usage [days/year]	Energy [kWh/year]
Generic Storage Water Heater	13,570	50	2,000	0.816	365	298

Table 56 Baseline data for storage water heaters.

The energy efficiency is determined from the stated data on the Indian energy label on the surveyed heaters.

Baseline Energy Consumption

Item	No.	Energy [kWh/day]	Energy [kWh/year]	Total Energy Consumption [MWh/year]
Storage Water Heaters	17,000	0.816	298	5,063

Table 57 Baseline energy consumption of storage water heaters.

Energy Savings

The potential energy saving for storage water heaters is based on the energy performance criteria in the Indian energy rating scheme. The test measures the electricity consumption for maintaining a water temperature of 45°C inside the tank over a 24 hours' period. The average star rating of the surveyed water heaters was 4-stars as per the Indian energy rating scheme. The star rating is based on standing losses in kWh/day for various sizes of heaters. The table below show the criteria for a 50 litres storage water heater.

Stars	Standing Losses [kWh/day]
1	1.086
2	0.988
3	0.898
4	0.816
5	0.742

Potential Savings for improving the baseline level to 5-stars	
Description	Standing Losses [kWh/day]
Baseline (4-stars)	0.816
5-stars	0.742
Energy Savings	**0.074**
Energy Savings %	**9%**

Table 58 Energy rating criteria in the Indian energy rating scheme for a 50 litres storage water heater, and calculation of savings if the baseline efficiency is improved to the 5-stars level.

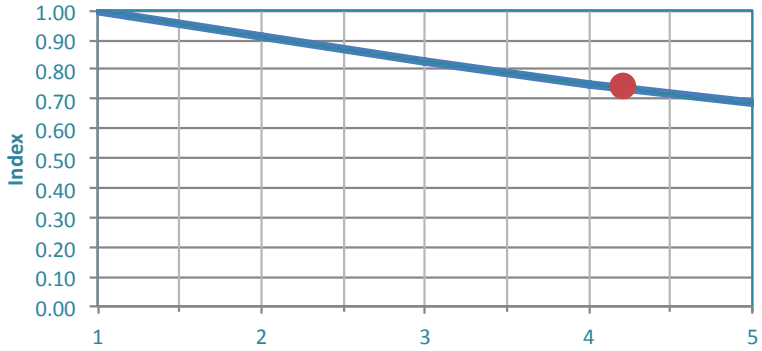


Figure 59 Energy savings according to the Indian energy rating scheme. Baseline is estimated to be around 4-stars.

Description	Number	Standing Losses [kWh/day]	Usage [Days/year]	Energy Consumption [MWh/year]
Baseline	17,000	0.816	365	5,063
Potential	17,000	0.742	365	4,604
		Energy Savings	**459 MWh/year**	
		Energy Savings %	**9%**	

Table 59 Potential energy savings for 5-stars water heaters.

Cost Implications

The average price for 5-stars storage water heaters are calculated based on the prices of the 5-stars rated models in the retailer survey.

Description	Unitary Price [Nu/l]	Price [Nu.]
Baseline	271	13,570
5-stars	339	16,951
Premium	**68**	**3,381**
Premium %	**+25%**	

Table 60 Cost comparisons of baseline and 5-stars storage water heater with 50-litre capacity.

2.18 Fans

Technology

Fans are used to introduce movement in the room air to create a chill factor felt by the occupants. Fans use an electrical motor to rotate the blades, and the efficiency of the fan is determined by the air delivery the blades generate. Fans come in various types from slow rotating ceiling fans, to smaller wall, stand and table fans.

Ceiling fan

Wall fan

Table fan

Stand fan

Market

The fan import has been around 30,000 units per year over the most recent 3 years.

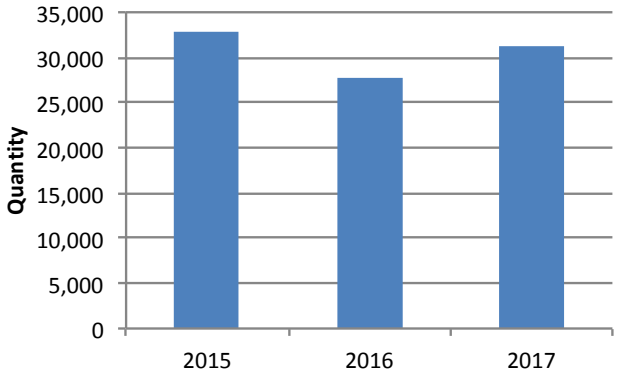


Figure 60 Import of fans in the period 2015-2017 (Source: Bhutan Trade Statistics)

Import in 2017 was 31,300, which is almost solely from India. According to the trade statistics 97% were from India in 2017, while all the fans recorded in the retailer survey were from India.

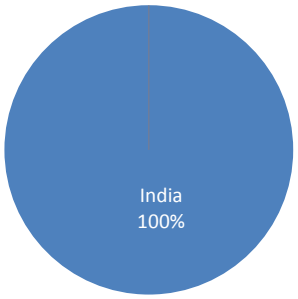


Figure 61 Share of imports of fans in the retailer survey. (Source: Retailer survey 2018)

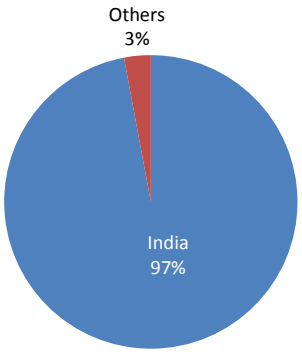


Figure 62 Share of imports of fans in the trade statistics. (Source: Bhutan Trade Statistics 2017)

Baseline quantity of water fans: 33,000

Current Labeling Status

Although India has a voluntary labeling scheme for ceiling fans, none of the fans found in the retailer survey were labeled.

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 10 models of various fan types such as ceiling, stand, table and wall fans were found during the survey. The stand, table and wall fans are often similar models, just with a different mount.

Item	Price [Nu]	Swept Area [m]	Power [W]	Usage [hours/year]	Energy [kWh/year]
Generic Fan	1,970	0.8	51	1,460	74

Table 61 Baseline data for fans.

The annual usage of fans in Bhutan is assumed to be 4 hours per day on average. The Thailand energy rating scheme for table fans uses 8 hours per day as a basis, but as the climate is more temperature in Bhutan it is assumed that the usage is about half i.e. less use in the colder months.

Baseline Energy Consumption

Item	No.	Power [W]	Annual Usage [hours/year]	Total Energy Consumption [MWh]
Fans	33,000	51	1,460	2,457

Table 62 Baseline energy consumption of fans.

Energy Savings

The potential energy savings are based on the energy performance criteria in the Indian energy rating scheme. The test is based on measurements of air delivery, fan speed and power consumption to calculate the service value. As none of the surveyed fans were labeled, the service value for the fans in the market is unknown. It is therefore assumed that the average efficiency is equivalent to the 3-stars Indian criteria.

Stars	Service Value
1	3.2
2	3.4
3	3.6
4	3.8
5	4.0

Potential Savings for improving the baseline level to 5-stars	
Description	Service Value
Baseline (3-stars)	3.6
5-stars	4.0
Energy Savings	**-**
%	**10%**

Table 63 Energy rating criteria in the Indian energy rating scheme for ceiling fans, and calculation of savings if the baseline efficiency is improved to the 5-stars level.

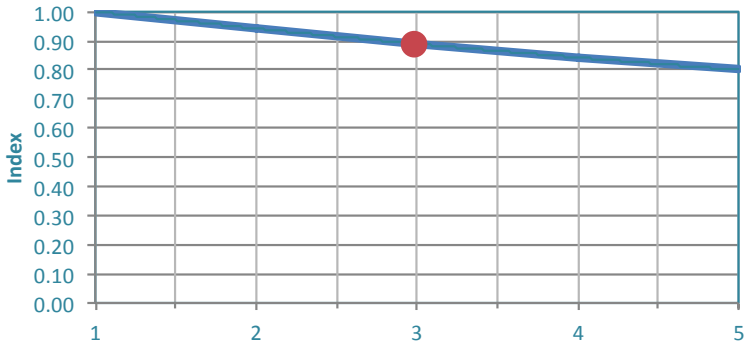


Figure 63 Energy savings according to the Indian energy rating scheme. Baseline is estimated to be 3-stars.

Description	Number	Service Value	Usage [Hours/year]	Energy Consumption [MWh/year]
Baseline	33,000	3.6	1,460	2,457
Potential	33,000	4.0	1,460	2,211
		Energy Savings	**246 MWh/year**	
		Energy Savings %	**10%**	

Table 64 Potential energy savings for 5-star fans.

Cost Implications

The average price for the 5-stars fans is based on the average price for a sample of 5-stars rated fans in India[9].

Description	Price [Nu]
Baseline	1,970
5-stars	2,530
Premium	**560**
Premium %	**+28%**

Table 65 Cost comparisons of baseline and 5-stars ceiling fan.

[9] Prices are obtained from Amazon.in based on price search for 5 selected models from the BEE energy rating database.

2.19 Air Conditioners

Technology

Air conditioners create a cooling cycle, where heat is absorbed from the indoor air and released to the outdoor air. The central part is a compressor that pump refrigerant through the cycle of evaporation and condensation. Most models are split systems, where fan assisted evaporators are located indoor, while the condenser and compressors are located outdoor. For larger systems one condenser unit may service multiple indoor units. Smaller systems can be a unitary air conditioner, which is window mounted, with the evaporator facing the room side, and the condenser facing the outside. Others are free standing units, where the warm exhaust air from the condenser is channelled outside through a pipe or flexible hose.

The most common model available in Bhutan is the split unit system, with an indoor wall mounted fan unit and an outdoor condenser unit. The most energy efficient models are equipped with inverters to adjust the compressor speed and power to the cooling requirement. Others will switch between on and off depending on the indoor temperature.

Split unit | Multi-split unit | Window unit

Market

The market for air conditioners is still relatively small in Bhutan, but there is an indication that the sales are increasing. The need for air conditioning is mainly in the summer months, and mostly required in the lower altitudes and the southern region of the country. Air conditioners are mostly installed in commercial facilities, such as restaurants, hotels and offices. The household survey showed that only 1% of homes had air conditioners in 2014.

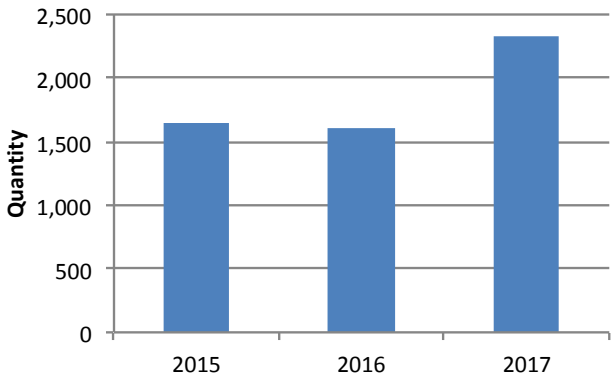


Figure 64 Import of air conditioners in the period 2015-2017. (Source: Bhutan Trade Statistics 2017)

Majority of air conditioners are imported from India. The retailer survey found models from India only, while the trade statistics registered 14% import from the UAE. The models that originate from UAE are from a brand that supplies from India, and the models are made for the Indian market.

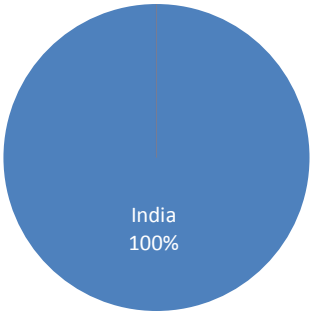


Figure 65 Import shares for air conditioners as per the retailer survey. (Source: Retailer survey 2018)

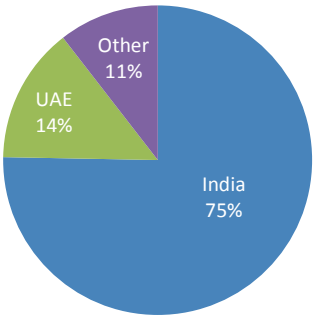


Figure 66 Import shares for air conditioners in 2017. (Source: Bhutan Trade Statistics 2017)

Baseline quantity of Air Conditioners: 2,000

Current Labeling Status

Most models are from India, or for the Indian market, where energy labeling is mandatory. Thus 90% of the models surveyed were labeled. The AC models sampled were in 2 to 5-stars range with majority being 3-stars labelled.

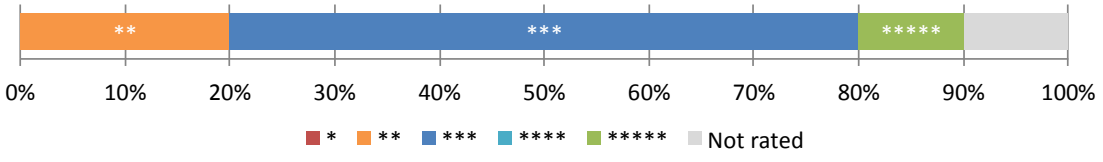


Figure 67 Air conditioners with energy label. (Indian label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 10 models of air conditioners were recorded in the survey ranging from 3.3 kW to 6.2 kW cooling capacity.

Item	Price [Nu]	Cooling Capacity [W]	Power [W]	EER [W/W]	Usage [hours/year]	Energy [kWh/year]
Generic Air Conditioner	39,300	4,715	1,386	3.4	365	506

Table 66 Baseline data for air conditioners.

The annual energy consumption is determined from the energy consumption from the Indian energy rating scheme. The efficiency is determined as the energy efficiency ratio between cooling output and power input. The Indian energy rating scheme calculates the annual energy consumption based on an assumption of 1600 cooling hours per year and uses a seasonal temperature variation. In Bhutan, where the average climate is colder than in India, the annual usage hours are less. It is therefore assumed that the full load operation hours are 365 hours per year. This is about 2 hours per day during the warmer summer period.

Air conditioners are controlled by a thermostat and starts and stops according to the indoor temperature. So, the air conditioner will often operate 50% of the time it is turned on. If the air conditioner is switched on for 8 hours, it may only operate for about 4 hours. If the air conditioner is an inverter model, the load of the compressor is adjusted to the cooling requirement and it operates at a lower load than full load.

Baseline Energy Consumption

Item	No.	Power [W]	Annual Usage [hours/year]	Total Energy Consumption [MWh/year]
Air Conditioners	2,000	1,386	365	1,012

Table 67 Baseline energy consumption of air conditioners.

Energy Savings

The average energy efficiency of the air conditioners surveyed shows and EER of 3.4 W/W. In the Indian energy rating scheme, this is called ISEER, which is a seasonal corrected EER. An analysis shows that the EER and ISEER are identical. The generic model of AC is equivalent to 2.5-stars.

Stars	EER
1	3.1
2	3.3
3	3.5
4	4.0
5	4.5

Potential Savings for improving the baseline level to 5-stars		
Description	EER [W/W]	Energy Consumption [kWh/year]
Baseline (2.5-stars)	3.4	506
5-Stars	4.5	382
Energy Savings	**1.1**	**124**
Energy Savings %	**24%**	

Table 68 Energy rating criteria in the Indian energy rating scheme for air conditioners, and calculation of savings if the baseline efficiency is improved to the 5-stars level.

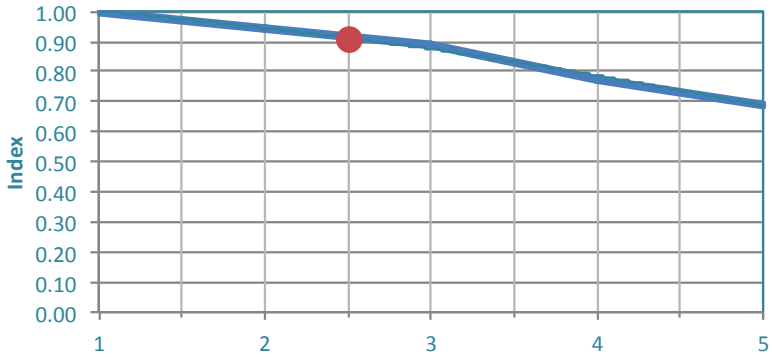


Figure 68 Energy savings according to the Indian Energy rating Scheme. Baseline is estimated to be 2.5-stars.

Description	Number	Unit Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	2,000	506	1,012
Potential	2,000	382	764
		Energy Savings	**247 MWh/year**
		Energy Savings %	**24%**

Table 69 Potential energy savings for 5-star air conditioners.

Cost Implications

The average price for 5-stars air conditioners is calculated based on the average price for the surveyed 5-stars models.

Description	Cooling Capacity [W_c]	Unit Price [Nu/W_c]	Price [Nu]
Baseline	4,715	8.3	39,300
5-stars	4,715	9.0	42,400
	Premium	**0.7**	**3,100**
	Premium %	**+8%**	**+8%**

Table 70 Cost comparisons of baseline and 5-stars air conditioners.

2.20 Reversible Heat Pumps

Technology

Heat Pumps are similar to air conditioners as they create a heating cycle, where heat is absorbed from the outdoors air and released to the indoor air. Reversible heat pumps can reverse the cycle, so it either heats up the indoor air or cools it down. The central part is a compressor that pumps refrigerant through the cycle of evaporation and condensation. Most models are split systems, where fan assisted evaporators are located indoor, while the condenser and compressor is located outdoor. For larger systems one condenser unit may service multiple indoor units. Smaller systems can be a unitary air conditioner, which is window mounted, with the evaporator facing the room side, and the condenser is on the outside. Others are free standing units, where the warm exhaust air from the condenser is channelled outside through a pipe or flexible hose. The most energy efficient models are equipped with inverters to adjust the compressor speed and power to the cooling requirement. Others will switch between on an off depending on the indoor temperature.

The most common model available in Bhutan is the split unit system, with an indoor wall mounted fan unit and an outdoor condenser unit. Reversible heat pumps are quite suitable to the Bhutanese climate as they can provide heating in the winter and cooling in the summer.

Split unit

Unitary model

Market

The market for heat pumps is quite small in Bhutan, but it is a technology that is expected to gain a market momentum as consumers start to know about the product and the benefits of having a device that can both heat and cool efficiently. Reversible heat pumps are especially appropriate in commercial premises such as restaurants, hotels, shops and offices, and also residential sector.

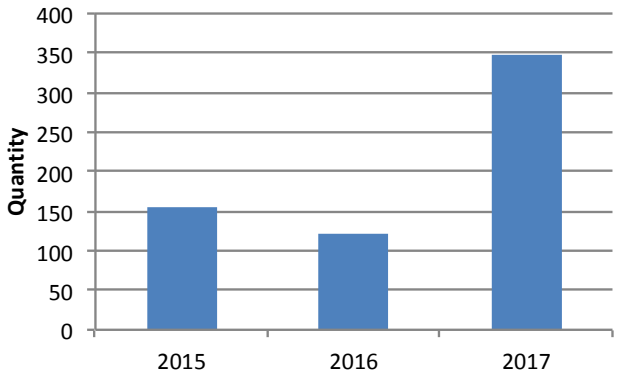


Figure 69 Import of reversible heat pumps in the period 2015-2017. (Source: Bhutan Trade Statistics 2017)

The main import of reversible heat pumps is from India, but some are also imported from UAE, China Thailand and Malaysia. The retailer survey found that the distributors were mainly sourcing from India and the products are mainly made for the Indian market.

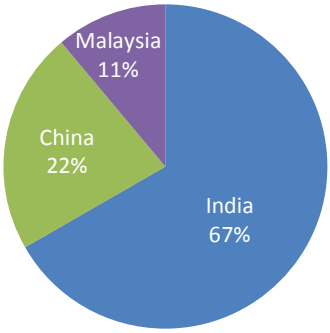


Figure 70 Import shares for heat pumps as per the retailer survey. (Source: Retailer survey 2018)

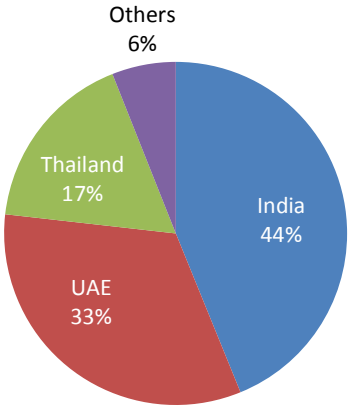


Figure 71 Import shares for heat pumps in 2017. (Source: Bhutan Trade Statistics 2017)

Baseline quantity of Heat Pumps: 300

Current Labeling Status

The majority of the heat pumps in the retailer survey are for the Indian market. These are labeled with the air conditioner label and rated according to the cooling efficiency. The heating efficiency is normally higher than the cooling efficiency, so it is valid to perform the rating with respect to cooling efficiency, as this will give a conservative value.

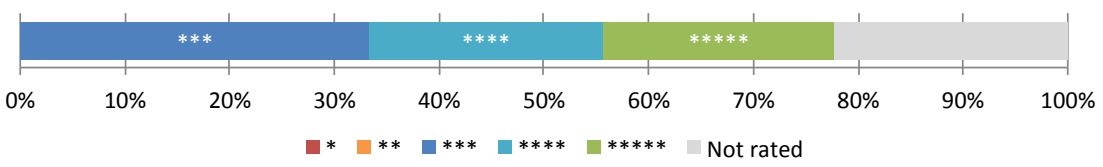


Figure 72 Heat pumps with energy label. (Indian label)

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 9 heat pumps were registered, ranging from 3.5 kW – 14 kW in heating/cooling capacity.

Item	Price [Nu]	Cooling Capacity [W]	Power [W]	EER [W/W]	Annual Usage [hours/year]	Energy [kWh/year]
Generic Heat Pump	46,550	5,879	1,832	3.2	730	1,337

Table 71 Baseline data for heat pumps.

The annual energy consumption is determined from the energy consumption stated in the Indian energy label, which is based on test results of the models. The efficiency is determined as the energy efficiency ratio between cooling output and power input. The usage hours are assumed to be double the usage hours for air conditioners, as the reversible heat pump may be operating as an air conditioner in the summer period and a heater in the winter period.

The heat pump is controlled by a thermostat and starts and stops according to the indoor temperature. So it will often operate 50% of the time it is on. So, if the heat pump is switched on for 8 hours, it may only operate for about 4 hours. If it is an inverter model, the load of the compressor is adjusted to the cooling or heating requirement and operates at a lower load than full load.

Baseline Energy Consumption

Item	No.	Power [W]	Annual Usage [hours/year]	Total Energy Consumption [(MWh/year]
Heat Pumps	300	1,832	730	401

Table 72 Baseline energy consumption for heat pumps.

Energy Savings

The average efficiency of the heat pumps surveyed is an EER of 3.2 W/W. The energy saving is based on the cooling EER, which is lower than the heating EER. As reversible heat pumps typically will be used for heating and cooling, it is reasonable to use the cooling EER as a reference for the overall efficiency as this is the most conservative value. The generic model is equivalent to 1.5-stars rating.

Stars	EER
1	3.1
2	3.3
3	3.5
4	4.0
5	4.5

Potential Savings for improving the baseline level to 5-stars		
Description	EER [W/W]	Energy Consumption [kWh/year]
Baseline (1.5-stars)	3.2	1,337
5-stars	4.5	951
Energy Savings	**1.3**	**386**
Energy Savings %	**29%**	

Table 73 Energy rating criteria in the Indian energy rating scheme for air conditioner (including heat pumps), and calculation of savings if the baseline efficiency is improved to the 5-stars level.

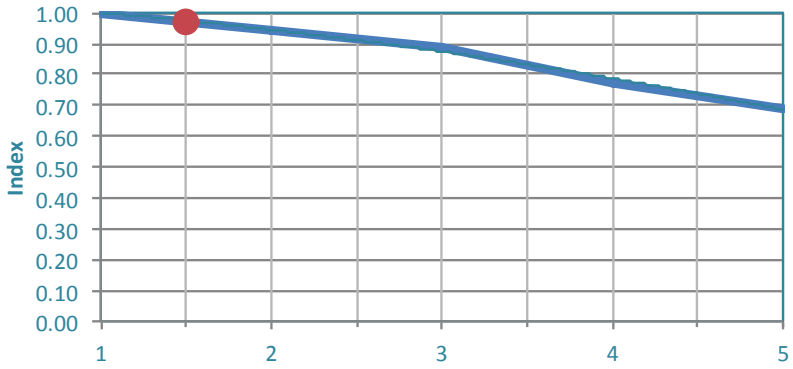


Figure 73 Energy savings according to the Indian energy rating scheme. Baseline is estimated to be 1.5-stars.

Description	Number	Unit Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	300	1,337	401
Potential	300	951	285
		Energy Savings	**116 MWh/year**
		Energy Savings %	**29%**

Table 74 Potential energy savings for heat pumps.

Cost Implications

The average price for a 5-stars reversible heat pump is calculated based on the average price for the surveyed 5-stars heat pumps.

Description	Cooling Capacity [W_c]	Unit Price [Nu/W_c]	Price [Nu]
Baseline	5,879	7.9	46,550
5-stars	5,879	10.3	60,554
	Premium	**2.4**	**14,004**
	Premium %	**+30%**	**+30%**

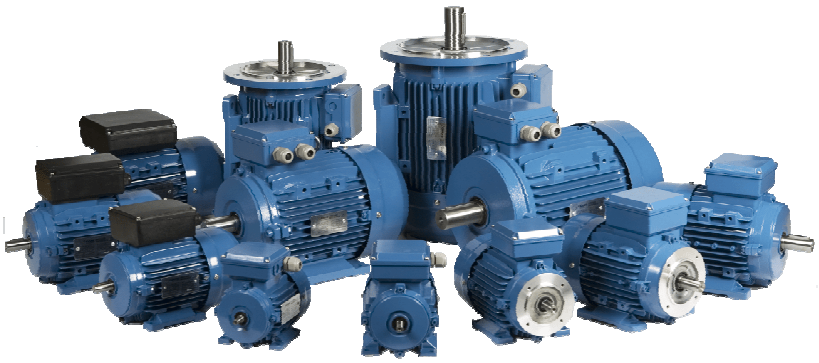
Table 75 Cost comparisons of baseline and 5-stars reversible heat pumps.

2.21 Electrical Motors

Technology

Electrical motors are used in many applications in industries, buildings and equipment. Energy rating of motors is for stand-alone motors and not for models built into equipment, such as pumps, fans and blowers etc. The size of standard motors normally ranges from 0.37 kW up to 375 kW, and typically come in standardized power outputs in kW or horsepower. Motors convert electrical energy into mechanical torque generated by an electro-magnetic field between the rotor and the stator. The efficiency heavily depends on the design and material used. A larger diameter on the copper wiring on the stator and more aluminium in the rotor reduces the losses as well as better cooling fan design, etc. will make the motor run cooler with less losses. This adds to the cost of the motor, but improves the efficiency and lowers the electricity costs.

The operation of motors varies a lot, depending on the application. Some will only operate shortly and have a lot of starts and stops, while others are running constant speed over long periods. However, many motors are running at various loads or a load lower than the design load. This may be due to the application or the standardized sizing of motors, which often leads to using a motor of a higher capacity than required. In these cases, it will save energy to install frequency controller that adjust the speed of the motor to meet the required loading and improve the efficiency.



Electrical motors

Market

The import of motors with a capacity between 0.75 kW – 375 kW varies a lot from year to year: 48 units were imported in 2015 and 178 units in 2017 but around 2,000 units in 2013. This witnesses that the procurement of motors is dependent on projects where new facilities or industries are being implemented. The replacement market seems to be very small.

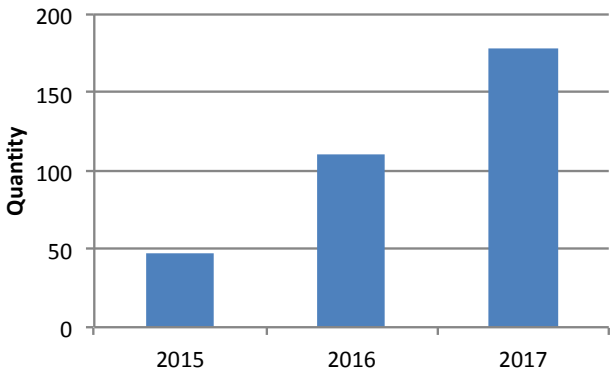


Figure 74 Import of reversible motors in the period 2015-2017

The data in the retailer survey is based on information from contractors and specific orders. A total of 15 motors were recorded in the survey and all were imported from India. The trade statistics registered a majority import from Japan in 2017, but as the import varies according to the projects and specifications, it is valid to assume that India is normally the main supplier.

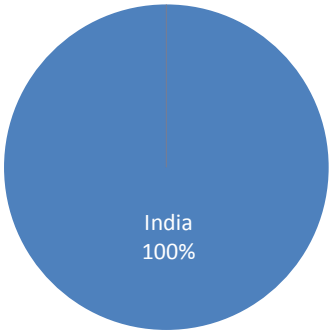


Figure 75 Import shares for motors as per the retailer survey. (Source: Retailer survey 2018)

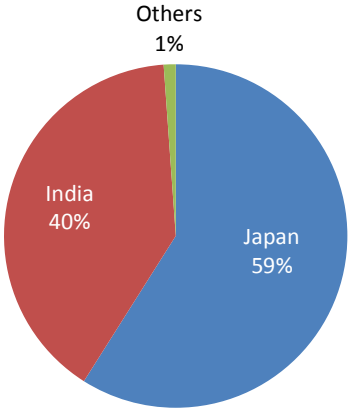


Figure 76 Import shares for motors in 2017. (Source: Bhutan Trade Statistics 2017)

Baseline quantity of motors: 100

Current Labeling Status

None of the motors surveyed were labeled, but majority of models have the efficiency stated on the nameplate. India has a voluntary labeling scheme for motors, which follows the ratings of CEMEP. CEMEP has 5 classes ranging from IE1 to IE5, where IE5 is the best. The Indian label gives 1-star to IE2, 3-stars to IE3 and then has two additional classes of 4 and 5-stars for IE4 and IE5. Only a few motors currently meet the IE4 and IE5 ratings, and IE3 is commonly referred to as the Premium Efficiency Class. Although India has 4 and 5 stars for the super-premium IE4 and ultra-premium IE5, there are no models registered with BEE in India under the rating scheme.

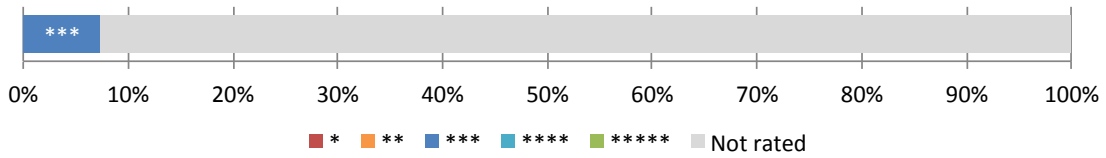


Figure 77 Motors with energy label.

Generic Product Definition

The generic product definition is based on the findings from the retailer survey. A total of 15 motors have been registered, ranging from 1.5 kW to 150 kW in volume.

Item	Price [Nu]	Power [kW]	Energy Efficiency [%]	Annual Usage [hours/year]	Energy [kWh/year]
Generic Motor	132,775	48	91.8%	1,460	70,080

Table 76 Baseline data for motors.

The annual energy consumption is determined based upon an assumption that motors on average operate at full load 1,460 hours per year, which is 4 hours per day. Motors can be used for many different applications in industries and buildings, some may operate 24/7, while other are only used occasionally.

Baseline Energy Consumption

Item	No.	Power [W]	Energy [kWh/year]	Total Energy Consumption [MWh/year]
Motors	100	48,000	70,080	7,008

Table 77 Baseline energy consumption of motors.

Energy Savings

The efficiency of the generic motor is 91.8%. This is based on the efficiency at optimum loading of the motor. Often motors operate in part load, where the efficiency may be significantly lower unless they are fitted with frequency converters. The energy rating of motors depends on the capacity and the number of poles. In general, larger capacity motors are more efficient than smaller motors. The generic model does not meet the 1-star rating criteria in India. Based on the efficiency, it would be considered as a standard motors (IE1) under the CEMEP rating scheme. The potential savings are calculated based on a change from the current baseline efficiency level to 3-stars, as it may be too difficult to procure any 4 and 5 star motors in this region. The data below is based on the energy rating criteria for 45 kW, 4 poles motors.

Stars	Efficiency (%)
1	93.1
2	93.7
3	94.2
4	94.9
5	95.6

Potential Savings for improving the baseline level to 3-stars		
Description	Efficiency [%]	Energy Consumption [kWh/year]
Baseline	91.8	70,080
3-stars	94.2	68,294
Energy Savings	**2.4**	**1,786**
Energy Savings %	**2.5%**	

Table 78 Energy rating criteria in the Indian energy rating scheme for 45 kW, 4 poles motors, and calculation of savings if the baseline efficiency is improved to the 3-stars level.

The energy efficiency varies with the capacity of the motor. For large motors the difference in efficiency is not so significant in the star rating but as they consume a lot of power, the small efficiency gain may result in overall high energy savings.

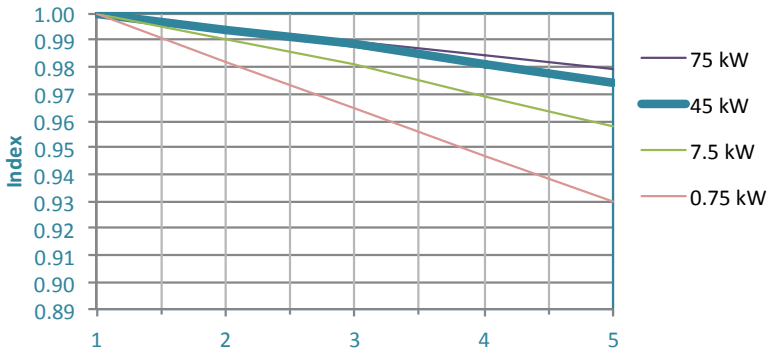


Figure 78 Energy savings for 4-poles motors according to the Indian energy rating scheme.

Description	Number	Unit Energy Consumption [kWh/year]	Energy Consumption [MWh/year]
Baseline	100	70,080	7,008
Potential	100	68,294	6,829
		Energy Savings	**179**
		Energy Savings %	**2.5%**

Table 79 Potential energy savings for motors.

Cost Implications

The average price for the 3-stars motor is based on the 2018 price list from an Indian manufacturer[10]. It is based on a 3-stars 45 kW, 4 Pole motor.

Description	Capacity [kW]	Price [Nu]
Baseline	45	132,775
3-stars	45	162,320
	Premium	**29,545**
	Premium %	**22%**

Figure 79 Cost comparisons of a baseline and a 3-stars motors.

[10] Havells India Limited

2.22 Summary

This section provides a summary of the baseline analysis and basis for the economic analysis in the next chapter. The details for the data can be found in the previous sections.

Baseline data for appliances

Appliance	Unit Energy Consumption [kWh/year]	Unit Energy Savings [%]	Unit Energy Savings [kWh/year]	Baseline Unit Price [Nu]	Premium [%]	Unit Premium Investment [Nu]
Lamps	31	60%	18	123	128%	158
Rice Cookers	159	13%	20	3,386	67%	2,260
Water boilers	147	9%	13	1,680	12%	199
Refrigerators	251	43%	109	21,828	25%	5,422
Curry Cookers	124	6%	8	1,440	12%	173
Induction Cookers	234	27%	63	3,640	12%	437
Televisions	66	27%	18	22,268	32%	7,081
Washing Machines	41	30%	12	16,700	23%	3,778
Room Heaters	716	78%	557	5,144	263%	13,510
Microwave Ovens	96	17%	16	8,576	6%	525
Storage Water Heaters	298	9%	27	13,570	25%	3,381
Fans	74	10%	7	1,970	28%	560
Air Conditioners	506	24%	124	39,300	8%	3,100
Reversible Heat Pumps	1,337	29%	386	46,550	30%	14,004
Motors	70,080	2.5%	1,786	132,775	22%	29,545

Table 80 Summary of the baseline data for generic models of the appliances.

Baseline data for the total annual market

Appliance	Baseline Market [Quantity]	Total Baseline Consumption [MWh/year]	Potential Savings [MWh/year]	Total Premium Investment [Million Nu.]
Lamps	500,000	15,497	9,125	79.00
Rice Cookers	39,000	6,286	780	88.14
Water boilers	38,000	5,687	49	7.56
Refrigerators	12,000	3,038	1,308	65.06
Curry Cookers	30,000	3,837	234	5.1
Induction Cookers	4,000	1,003	253	1.75
Televisions	3,000	198	54	21.24
Washing Machines	6,000	273	74	22.67
Room Heaters	11,000	8,443	6,132	148.61
Microwave Ovens	2,000	205	22	1.05
Storage Water Heaters	17,000	5,296	459	57.48
Fans	33,000	2,497	246	18.48
Air Conditioners	2,000	1,263	247	6.20
Reversible Heat Pumps	300	501	116	4.20
Motors	100	13,513	179	2.95

Table 81 Baseline data calculations for the whole market of appliances in 2017.

Validity of Data

In order to check the overall validity of the data and the assumption a crosscheck is done to evaluate if the assumed appliance consumption calculations match the overall electricity consumption data. Based on the baseline data and the household ownership data from 2015, the total residential consumption is calculated for the year 2015. There were 139,532 total number of residential customers in 2015[11].

Appliance	Unit Energy Consumption [kWh/year]	Ownership [%]	Units in homes [Quantity]	Total Energy Consumption [GWh]
Lamps	31	100%	5	22
Rice Cookers	159	96%	1	21
Water boilers	147	92%	1	19
Refrigerators	251	77%	1	27
Curry Cookers	124	75%	1	13
Induction Cookers	234	0%	1	-
Televisions	66	75%	1	7
Washing Machines	41	52%	1	3
Room Heaters	716	48%	1	48
Microwave Ovens	96	47%	1	6
Storage Water Heaters	298	45%	1	19
Fans	74	32%	1	3
Air Conditioners	506	1%	1	0
Reversible Heat Pumps	1,337	17%	1	31
			Total Consumption [GWh]	**219**
			Residential Energy Sales [GWh]	**223**
			Difference	**-2%**

Table 82 Comparison of baseline data with the household survey data from 2015.

Therefore, the total residential electricity consumption is calculated as 219 GWh. The actual residential electricity consumption in 2015 was 223 GWh based on the energy sales to residential customers in the year. The difference is 2%. It is expected that the actual electricity consumption is slightly higher, as there is additional consumption in the household for other appliances and equipment, which is not covered by the baseline analysis e.g. computers, chargers and other smaller devices.

[11] Source: Power Data Book 2015, Bhutan Power Corporation Limited.

3 Economic Analysis

This chapter presents the findings from the economic analysis of the potential energy and cost savings from promoting energy efficient appliances in Bhutan. The purpose of the analysis is to evaluate the appropriateness for developing standards and labeling for them and to select the most suitable appliances for implementation.

3.1 Economic Analysis Methodology

The basis for the analysis is the baseline data presented in the previous chapter. Each technology has a potential for saving energy, if the energy performance of the appliance is improved from the current level to an energy efficient level – expressed as 5-stars for most of the appliances. This improvement comes with a cost, as more efficient appliances are more expensive than the less efficient appliances. This is expressed as the premium cost in the baseline analysis.

The simple micro economic perspective for consumers is whether the energy cost savings will pay back the premium cost for the appliance, expressed as the payback period. It is also important how long the payback period is for the attractiveness of the investment. Most consumers are interested in a short payback period. Long pay back periods are less attractive, and payback periods longer than the service life of the appliances are not feasible.

The socio economic perspective for the nation is whether it benefits the country to promote energy efficiency. This takes into account the benefits for the consumers and the nation in terms of fiscal benefits (including avoided subsidies for domestic electricity supply). This analysis uses the market data on the sales of appliances to scale up the savings, costs and benefits to the national level. The key indicator for the feasibility is the benefit-cost-ratio (BCR), which is a ratio between the lifetime monetary savings and the total cost. The total cost is the total capital expenditure including the total premium cost for energy efficient appliances and the promotion and programme cost. However, in this analysis, where the purpose is to select the most appropriate appliances for S&L scheme, the programme cost is not budgeted. The programme cost will only be known after more detailed implementations plans have been developed for the selected appliances.

The analysis method is a cost effectiveness analysis, where the cost for saving energy is evaluated against the overall saving potential. Some appliances may be very cost effective, but due to a small market the overall savings are limited.

3.2 Service Life of Appliances

To evaluate the lifetime savings, the service life of the appliances must be known. It is very difficult to set a definite time period for how long an appliance will be in use. There are, in principle, two ways to assess the service life: one, is to consider the technical life, which is the

period of time the appliance *can be in operation* until the time when it will reach a poor condition beyond repair, and the other, is to consider the time the appliance *will be in operation* by the consumer. Often, appliances are replaced before they are faulty. This can be because new and smarter appliances with new features, design etc. becomes available in the market. An example could be how LED TVs are replacing CRT TVs. This is often not because the old CRT TV is faulty, but because the consumer wants the new TV technology and improved picture, screen size, features, etc. A TV may work for 15 years, but is often replaced earlier as it is deemed technological obsolete by the consumer, as it lacks the features and functions of new models. Many smaller household appliances, such as cookers, water boilers etc. are also often replaced before the end of the technical time, due to wear and tear from the use of the appliance.

Another aspect that is important to consider is the economic life. This is time period where the appliance is more economical to use rather than replace. New technologies with lower energy consumption may replace old appliances because the energy savings will make it feasible. An example is the replacement of lamps with LED. It is feasible to replace a fully functional incandescent or fluorescent lamp with an LED, because the energy savings will pay back the new lamp in a short period of time.

Therefore, the analysis is based on assumed service life of the appliances, which is the expected time the appliance will be in use by the consumer. This time is shorter than the technical time, but considered to be a realistic time for the energy savings to occur. The table below shows the expected service life for the energy efficient technologies to replace the baseline appliances.

Appliance	Service Life [Years]	Remarks
Lamps	10	LED lamps have a technical lifetime up to 50,000 hours. The average usage of the lamps in the baseline is 1,460 hours per year. So ideally LED lamps could last up to 30 years. However most lamps would be replaced within a 10-year period, either due to renovation works or because new and better lamp technologies become available
Rice Cookers Water boilers Curry Cookers Induction Cookers Microwave Ovens Televisions Fans	8	Small appliances that is used daily will be exposed to wear and tear. Normally technical life for small appliances is about 5-10 years, so the service life is considered within this period.
Refrigerators Washing Machines Room Heaters Storage Water Heaters Air Conditioners Reversible Heat Pumps	10	Large household appliances, which are stationary, have a technical life of up to 15 years. The service life is assumed to be around 10 years, due to wear and tear, and that the technologies may become obsolete as new technologies appear in the market.
Motors	10	Motors in industries are considered to have a technical life up to 15 years. However, it depends on the operation. Especially the number of starts and stops will reduce the life of the motor. Also the environment in which the motor operates may deteriorate the motor faster. The service life is assumed to be around 10 years on average of the motors.

Table 83 Service life of appliances is inspired by the technical life times suggested by the International Association of Certified Home Inspectors – InterNachi. (https://www.nachi.org/life-expectancy.htm)

3.3 Micro Economic Analysis – Consumer Perspective

The procurement process and purchase decision for consumers are based on many parameters, one of which is the price of the appliance. Energy efficient appliances come with a price premium over the standard appliances commonly sold in the market. If the price premium is countered by a reasonable energy cost savings, it is more likely that the consumer will accept the higher cost of the product. The cost saving potential must be informed to the consumer, and this is what energy labels and awareness campaigns can do. The micro economic analysis evaluates the energy cost savings against the premium cost for the energy efficient appliance in a simple payback time, which is an indicator that consumers can understand and relate to.

The simple payback time is the ratio between the premium cost and the annual energy cost savings. It provides the years to recover the premium cost. The energy cost saving is based on the marginal tariff rate for low voltage domestic consumers i.e. 3.53 as per 1st July 2018. The simple payback time does not take into account any future price increases on electricity, nor the discounted value of the saving in the future years. The table below shows the payback time for the premium cost of energy efficient appliances compared to baseline appliances. The appliances are ranked in ascending order with the shortest payback first.

Appliance	Service Life	Baseline Energy Consumption	Potential Saving	Energy Savings	Baseline Price	Premium	Energy Cost Savings	Premium Cost	Pay Back Time
	Years	kWh/year	%	kWh/year	Nu	%	Nu/year	Nu	Years
Induction Cookers	8	230	27%	62	3,640	12%	219	437	2.0
Lamps	10	31	60%	19	123	128%	66	158	2.5
Water boilers	8	147	9%	13	1,680	12%	47	199	4.3
Motors	10	70,100	3%	1,786	132,775	22%	6,305	29,545	4.7
Curry Cookers	8	124	6%	7	1,440	12%	26	173	6.3
Room Heaters	10	716	78%	557	5,150	362%	1,966	18,650	6.9
Air Conditioners	10	506	24%	124	39,300	8%	437	3,100	7.1
Microwave Ovens	8	96	12%	12	1,050	50%	41	525	9.4
Reversible Heat Pumps	10	1,337	29%	387	46,550	30%	1,366	14,003	10.3
Refrigerators	10	251	44%	109	21,800	25%	385	5,450	14.1
Fans	10	74	9%	7	1,970	28%	24	560	21.3
Storage Water Heaters	10	298	9%	27	13,570	25%	95	3,380	35.5
Televisions	8	66	39%	26	22,000	33%	91	7,350	80.9
Washing Machines	10	41	30%	12	16,700	23%	43	4,778	87.0

Table 84 Ranking of appliances according to their payback time.

Induction cookers, lamps, water boilers and motors have a short payback period of less than 5 years. For the lamps, the baseline is quite well defined, whereas for induction cookers and water boilers, the baseline is based on an assumption that the models sold in the market currently has a medium energy efficiency equivalent to 3-stars energy rating in Thailand. From the product information it is not possible to precisely estimate the actual energy performance, so the payback time may be inaccurate. However, as the payback is significantly shorter than the service life of the product, which is 8 years, it is deemed economically feasible to purchase energy efficient induction cookers and water boilers.

The next group of appliances (curry cookers, air-conditioners and room heaters) have a longer payback period of 6.6 - 9.5 years. This time period is still within the service life of the appliances, which is 8-10 years. The consumer will therefore have a saving over the time the appliance is in use, although minimal. For this group of appliances, it may be necessary to provide some incentives to improve the payback time. In order for the investment to be attractive, it would typically be required that the payback time should at a minimum be about half that of the service life. This means the premium cost should be about 50% lower, which could be achieved by providing incentives in the form of cash rebates.

The last group of appliances has a payback time that exceeds the service life and will not be able to recover the premium cost. Thus it would not be considered feasible from an economic point of view. For these appliances, both fiscal incentives and non-monetary benefits of the energy efficient appliances must be applied.

The table below indicates the necessary incentive for the energy efficient appliances to be attractive to the consumers, based on the assumption that the payback time should be half of the service life of the appliance.

Appliance	Service Life	Energy Cost Saving	Premium Cost	Incentive	Pay Back Time
	Years	Nu/year	Nu	Nu	Years
Induction Cookers	8	223	437	0	2.0
Lamps	10	64	158	0	2.5
Water boilers	8	46	199	15	4.0
Curry Cookers	8	28	173	63	4.0
Air Conditioners	10	437	3,100	917	5.0
Room Heaters	10	1,968	13,510	8,683	5.0
Refrigerators	10	385	5,422	3,498	5.0
Reversible Heat Pumps	10	1,364	14,004	7,185	5.0
Microwave Ovens	8	56	525	302	4.0
Fans	10	26	560	429	5.0
Motors	10	6,303	29,545	0	5.0
Rice Cookers	8	71	2,260	1,978	4.0
Storage Water Heaters	10	95	3,381	2,904	5.0
Televisions	8	64	7,081	6,827	4.0
Washing Machines	10	43	3,778	3,561	5.0

Table 85 Required amount of support to reduce the premium cost in order to achieve an acceptable payback time.

If there are no incentives or if there is a lower incentive, the impact of an implementation programme will be lower, as it may only be a small group of consumers who may find the energy efficient appliance economically attractive. These could be some, who use the appliances more than the average usage hours given in the baseline study.

3.4 Macro-Economic Analysis – Market Perspective

The market perspective is based on the impact on the whole market and the potential national savings and costs. The sale of appliances and use of electricity are closely connected, and the more appliances people buy and use the more electricity will be consumed. The market consists of two components, where the first one is new purchases: Consumers buy appliances for the first time or increase the range of appliances for their home or facility, which increases the total stock of appliances in use in the country. The second component is replacement, where the purchase replaces a current appliance in use, as it has reached the end of its service life or for other reasons: This purchase does not increase the overall stock of the appliances.

The analysis only takes into account the energy savings that energy efficient appliances will provide compared to the baseline appliance that the consumer is likely to buy, if there is no promotion of the energy efficient appliance. It does not take into account the energy saving that may occur when an old and in-efficient appliance in the consumers' home is replaced with a new model. This energy saving is considered a part of the baseline, as the consumer would have bought a technology that has an efficiency equivalent to the baseline (generic) appliance.

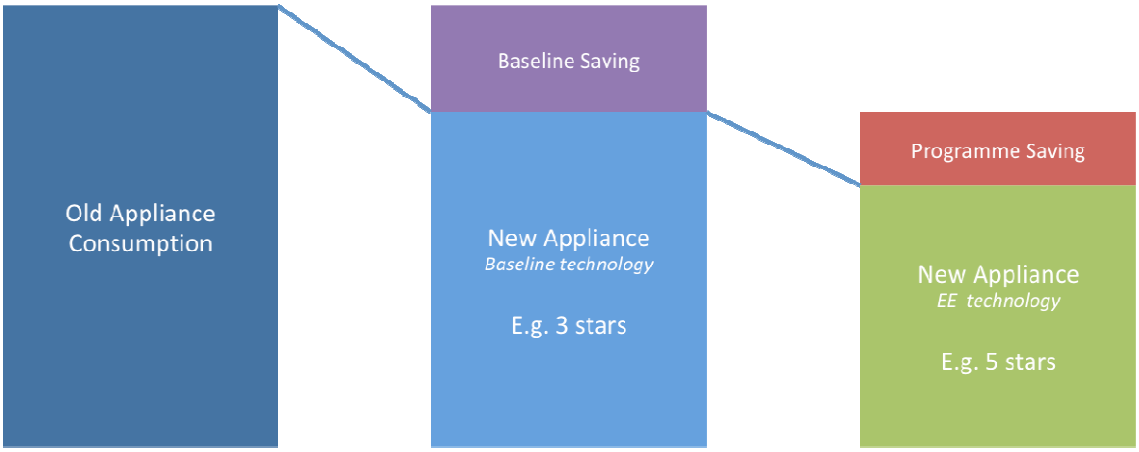


Figure 80 Energy savings from replacement of existing stock of appliances. Only the saving from choosing the 5 stars over the 3 stars is part of the programme energy savings.

Similarly, the cost of the new appliance is not fully considered as programme cost, as the cost of the baseline technology (e.g. 3-stars) would have occurred anyway and is part of the baseline. Only the premium cost for the choosing the energy efficient technology is considered (i.e. for example, the difference in cost between the 3-stars and 5-stars technology).

Market Development

The development of the market is based on an overall projection of the electricity demand, which assumes that the increase in electricity demand and consumption is a result of more appliances being installed and used. The projection could also be made from the import and sale of appliances, but as it can be seen in the baseline study the import quantities are small for most appliances and there are inconsistent variations. A few building projects can impact the statistics in a given year, so the variation can be high. Additionally, the market for appliances is still expanding as some consumers are only recently connected to the power grid, and is buying electrical appliances for the first time.

The projection of the electricity consumption is based on a simple extrapolation of the past 5 years' electricity consumption and the annual average growth rate is estimated to be around 3% p.a. for all sectors and 3.8% for domestic, commercial and institutional sectors only. The growth projection in appliances is assumed to be 3.5% p.a.

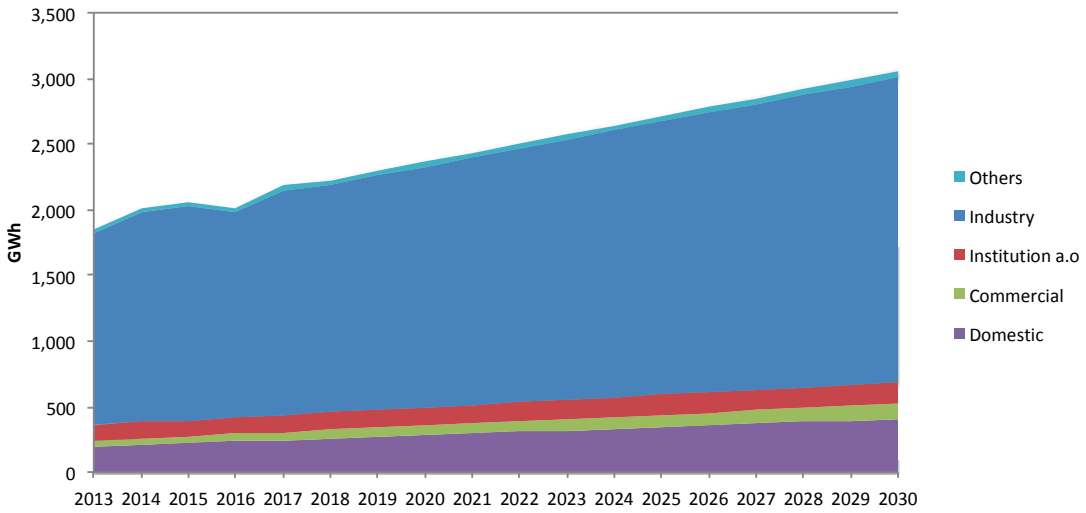


Figure 81 Projected growths in electricity consumption for all sectors. (Year 2013-2017 data from Power Data Book 2017, Bhutan Power Corporation Limited)

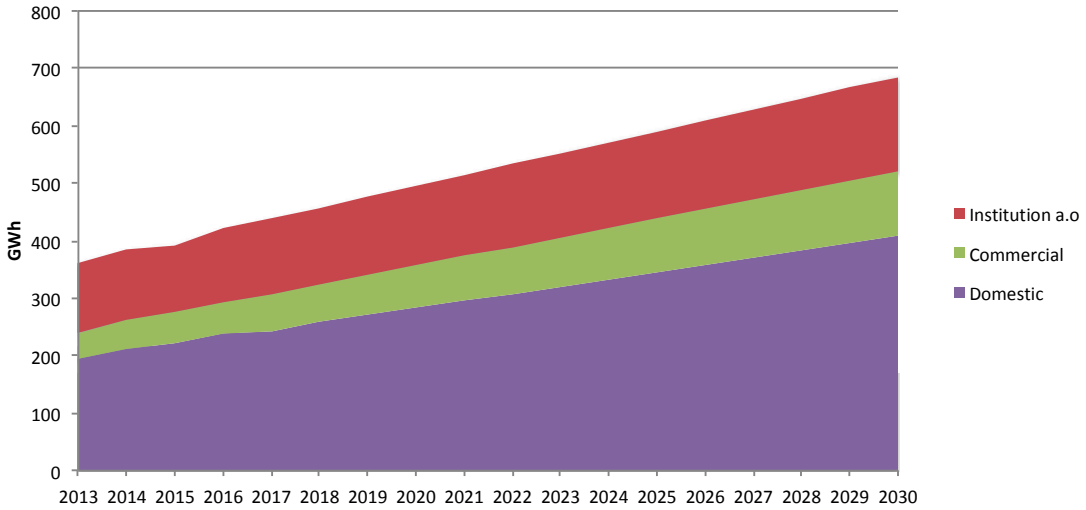


Figure 82 Projected growths in electricity consumption for domestic, commercial and institution sectors. (Year 2013-2017 data from Power Data Book 2017, Bhutan Power Corporation)

The aim of standards and labeling and promotion of energy efficiency for appliances is to improve the energy performance, so the growth in appliance stock does not increase the energy consumption or even cause a reduction in the energy consumption in the long term. The appliance market development is projected based on the general growth projection of 3.5% p.a.

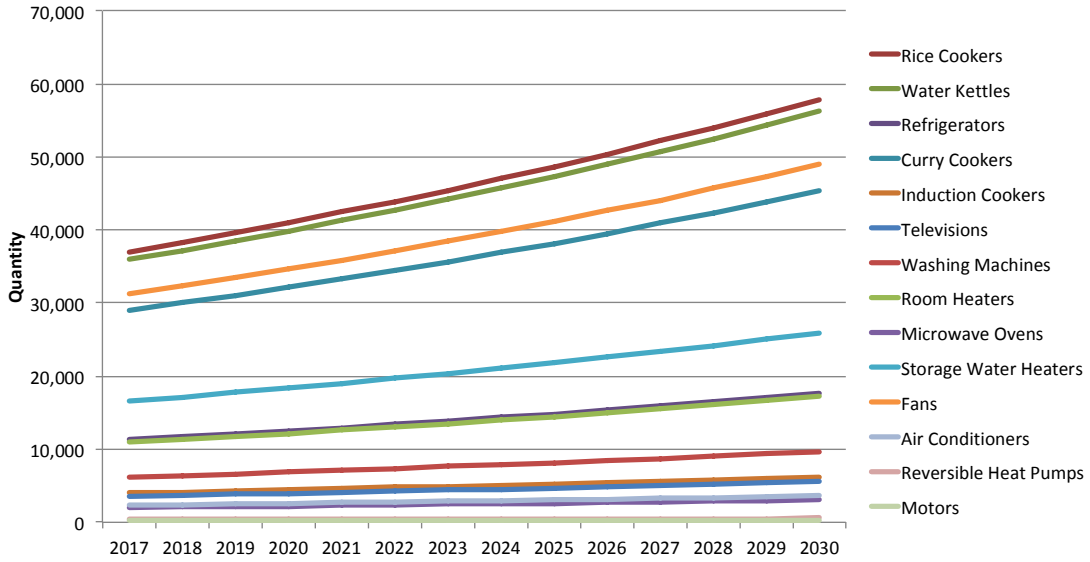


Figure 83 Appliance market projection based on 3.5% p.a.

The above development is expected for most appliances, except for lamps. As LED lamps are already available in the market and are getting an increased demand, this development will impact the sale of lamps in the future. LED lamps have a lifetime that is 3-5 times longer than fluorescent lamps and 30-50 times longer than incandescent lamps. Thus the replacement of lamps in the future will decline, as more LED lamps are being bought and installed.

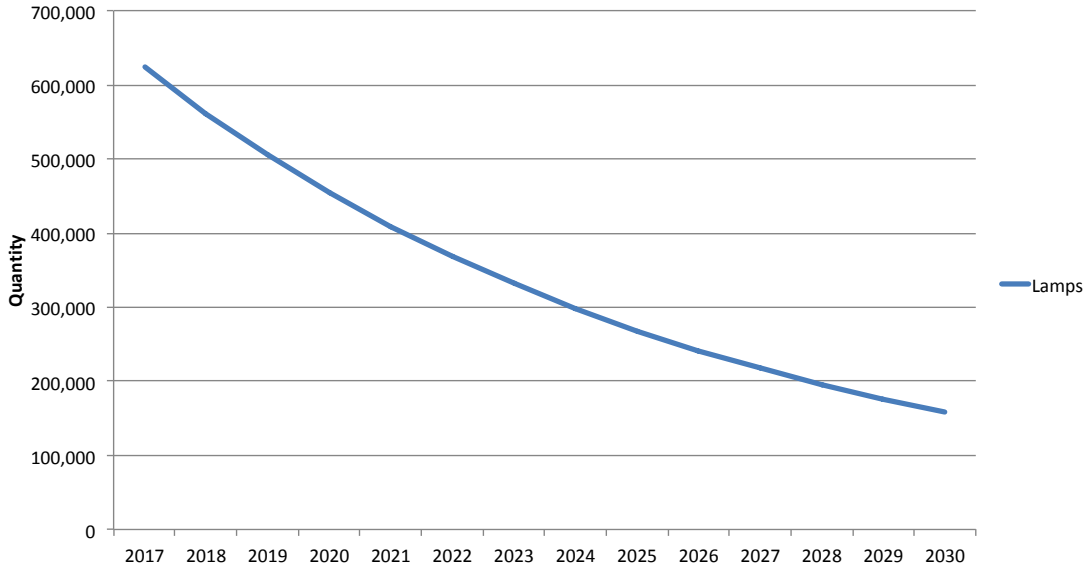


Figure 84 Estimated market developments for lamps.

The above projections are the business as usual development in the market without any interventions to promote energy efficiency. If LED lamps are further promoted the decline in the lamps market will happen faster as a result of the increased stock of LED.

Economic Analysis of the Appliances

The economic potential of energy efficiency improvement for each appliance is analysed for one year of sales and is based on full conversion of the market to the energy efficient appliance. A projection of the overall impact requires further design of the intervention in order to project the market transformation towards the new energy efficient technologies. The market transformation and the market penetration of energy efficient technologies will depend on the effort made by the intervention in terms of marketing and incentives.

However, not all appliances are suitable to target for development of an S&L scheme in Bhutan. Therefore, in order to select the most promising appliances, an evaluation of the feasibility is made to rank the most feasible appliances to target for further programme development.

The key indicator is the benefit cost ratio (BCR), which is the ratio between the overall benefits, in terms of monetary energy cost savings over the service life of the appliance and the premium cost to be paid for the more efficient appliance.

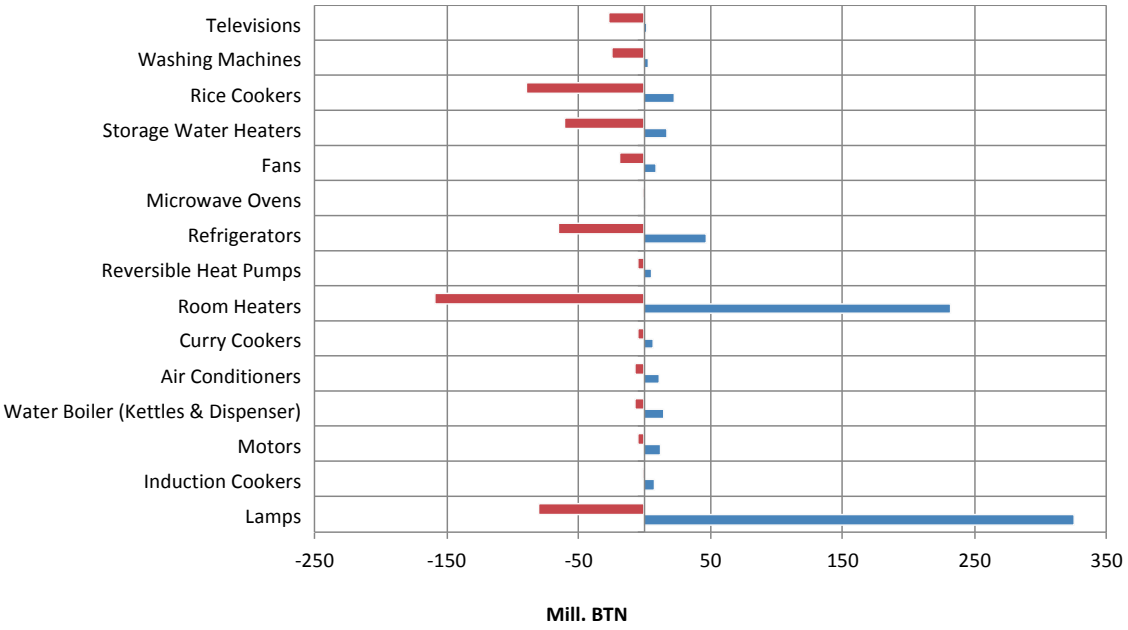


Figure 85 Cost and benefit of the appliances. Ranked from the least feasible in the top to the most feasible in the bottom. The red colour bars on the left show the costs and the blue colour bars on the right show the benefits.

The details of the cost and benefit can be found in the table below. The benefits in terms of electricity cost savings at the prevailing consumer tariff rate over the lifetime of the equipment, which is equal to the service life described earlier. The cost and benefit is calculated for the full market transformation in a year.

Appliance	Total Premium Investment	Total Lifetime Savings	Net Cost	Cost per kWh saved	BCR
	Nu	Nu	Nu	Nu/kWh	-
Lamps	79,859,520	92,243	-245,757,564	-2.66	4.08
Induction Cookers	1,872,501	2,170	-5,788,362	-2.67	4.09
Motors	5,696,882	3,443	-6,456,782	-1.88	2.13
Water boilers	7,674,256	4,026	-6,537,849	-1.62	1.85
Air Conditioners	7,737,458	3,087	-3,158,053	-1.02	1.41
Curry Cookers	5,374,336	1,938	-1,468,529	-0.76	1.27
Room Heaters	159,194,747	65,692	-72,699,015	-1.11	1.46
Reversible Heat Pumps	5,250,502	1,449	137,186	0.09	0.97
Refrigerators	65,632,456	13,194	19,056,654	1.44	0.71
Microwave Ovens	1,124,786	271	168,086	0.62	0.85
Fans	18,776,432	2,497	9,963,452	3.99	0.47
Storage Water Heaters	60,122,075	4,803	43,167,454	8.99	0.28
Rice Cookers	89,575,835	6,340	67,194,191	10.60	0.25
Washing Machines	25,091,946	817	22,208,982	27.19	0.11
Televisions	27,003,825	549	25,065,316	45.64	0.07

Table 86 Ranking of appliance from a high to low benefit-cost ratio.

The criteria for an investment to be feasible is that the BCR>1, so the benefits outweigh the cost. This is the case for the first 7 appliances, whereas the balance 8 appliances will have a premium cost that exceeds the savings.

The column “Cost per kWh saved”, show the additional cost there will be for every kWh of electricity that the appliance saves. This can be used as an indicator for how much the cost of electricity should increase in order for the investment to be feasible. For instance, the reversible heat pumps are very close to be feasible, if the cost of electricity increases by only 0.07 Nu/kWh.

Energy Saving Potential and Feasibility

The cost-benefit is not the only indicator that is important but also the cost effectiveness in terms of how effective a technology is to achieve energy savings. For this purpose, the appliances have been evaluated based on the marginal abatement cost (MAC), which is the cost of reducing 1 kWh of electricity. This is expressed as the cost per kWh saved in the table above, and shows how much it will cost in excess of the prevailing tariff to save a unit of electricity. For the top seven appliances there is a lower cost for saving electricity, than the domestic tariff, so these are highly feasible interventions for the society and the consumers.

A MAC-curve for the appliances is illustrated below, where the energy saving potential is shown on the horizontal axis and the abatement cost or cost per saved kWh is shown on the vertical axis. The appliances are ranked in terms of low to high marginal abatement cost.

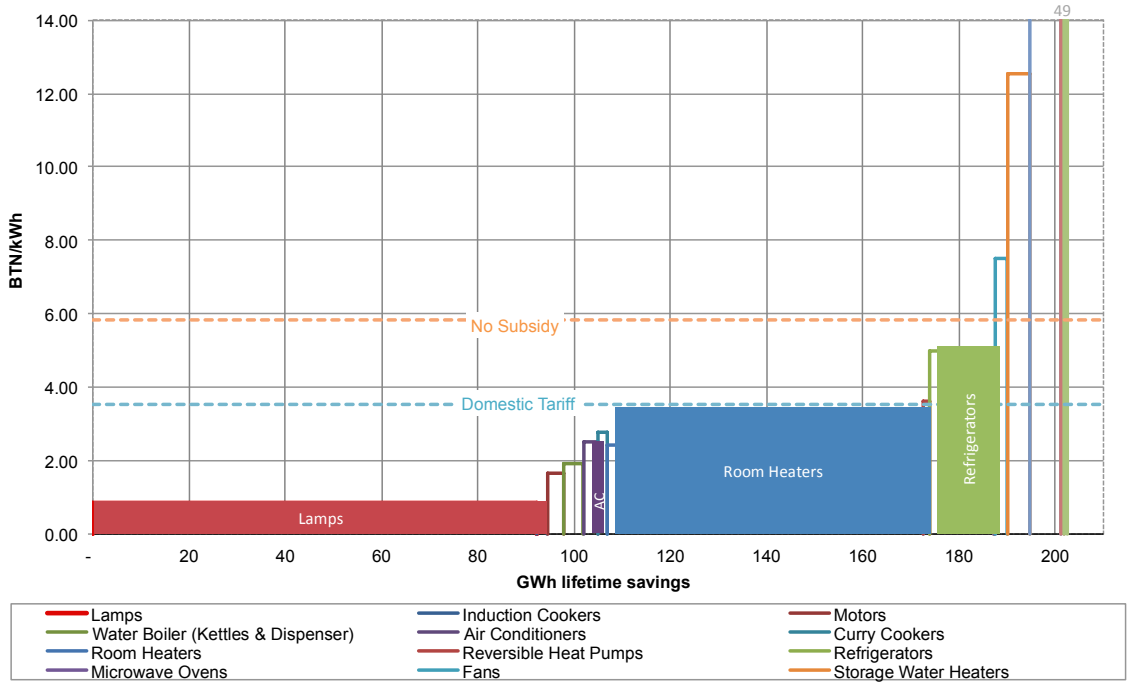


Figure 86 Cost of energy savings for the appliances ranked from the lowest to the highest cost.

Rice cookers, televisions and washing machines are the appliances with the highest cost. It can be seen that lamps have a high energy saving potential at a low abatement cost. This means that this appliance is highly feasible to promote in the market, as it will have significant impact on the overall national energy savings. However, the replacement of lamps is a short-term activity, which can be done in a limited period with high cost effectiveness. Due to the long lifetime of LED lamps the market will decline in the future years and mainly new installations will require lamps, whereas the replacement market will have diminished.

For induction cookers, water boilers and curry cookers the marginal abatement cost is also low and it is feasible to promote energy efficiency for these appliances. However, the overall energy saving potential is relatively small, so this must be considered when deciding on any programme or intervention. Furthermore, as mentioned earlier, the baseline efficiency of these appliances are somewhat uncertain, as the appliances are not labeled or carry energy performance data and further studies are required to determine the actual energy savings.

Air conditioners, room heaters and refrigerators also have low marginal abatement costs. Energy savings for these appliances are relatively high, but the abatement cost is close to the domestic tariff, but still lower than the unsubsidized price for electricity. This indicates that some support or incentives is required for the market transformation to happen.

Socio Economic Benefits

The cost of electricity in Bhutan is relatively low, which makes cost savings from energy efficiency interventions for electrical appliances, limited. The real cost of electricity is 5.82 Nu/kWh as of July 2018 and it is expected that this cost is the long-run marginal cost of power,

which includes the capacity, cost of operation of power generation and distribution costs. Operation cost is low for hydropower plants, whereas the capacity cost is high (i.e. the cost of building a hydropower plant). The subsidy for electricity is the difference between the consumer tariff and the real cost. On average the subsidy is 2.29 Nu/kWh.

An increase in electricity demand will require expansion of power generation capacity and therefore, saving electricity in the future will also reduce the need for additional power generation capacity. Therefore, investing in energy efficiency is an alternative to investing in power plants. The following assessment shows the potential subsidy savings per year from implementing energy efficiency interventions for appliances.

Appliance	Annual Subsidy Saving	Lifetime Subsidy Saving	BCR Socio	Socio Cost per kWh Saved
	Nu/year	Nu	-	Nu/kWh
Lamps	21,123,601	211,236,012	6.72	-4.95
Induction Cookers	621,224	4,969,795	6.75	-4.96
Water boilers	788,439	7,884,388	3.52	-4.17
Air Conditioners	1,152,469	9,219,751	3.05	-3.91
Curry Cookers	706,819	7,068,193	2.32	-3.31
Room Heaters	554,892	4,439,139	2.10	-3.05
Reversible Heat Pumps	15,043,533	150,435,330	2.40	-3.40
Refrigerators	331,714	3,317,137	1.61	-2.20
Microwave Ovens	3,021,490	30,214,897	1.17	-0.85
Fans	77,579	620,636	1.40	-1.67
Motors	571,720	5,717,202	0.77	1.70
Storage Water Heaters	1,099,889	10,998,890	0.46	6.70
Rice Cookers	1,814,942	14,519,537	0.41	8.31
Washing Machines	187,025	1,870,251	0.19	24.90
Televisions	157,195	1,257,560	0.12	43.35

Table 87 Ranking of appliances from high to low socio-economic benefits.

3.5 Labels in the Market

A large number of appliances are already labeled as they are imported from countries with labeling schemes in place, i.e., mainly India and Thailand. The retailer survey found that about 42% of the appliances were labeled of which the 35% had the Indian energy star label.

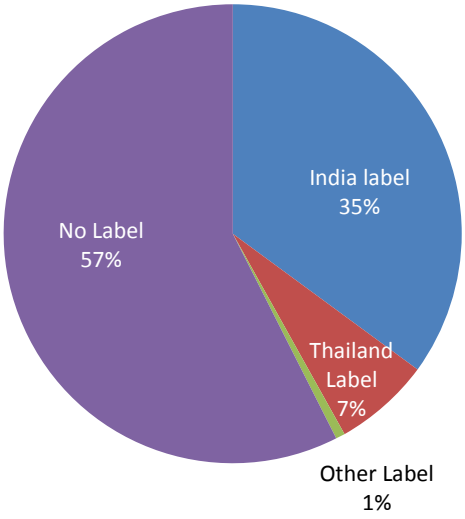


Figure 87 Labels in the Bhutanese market.

In certain product categories a large portion of appliances are labeled. This is evident for large appliances such as refrigerators, air conditioners, heat pumps, water heaters and TVs. The reason is that most of these products are imported from India, where labeling is mandatory for these appliances. Small kitchen appliances, such as cookers, some appliances are labeled with the Thai energy label, but as this label is voluntary only the 5-stars labels are applied. This means that a much smaller portion of the market has the Thai energy star label. Moreover, it is only possible to identify the 5-stars labeled products and not possible to compare energy efficiency across the stock of the appliances in the categories as per Thai energy rating criteria.

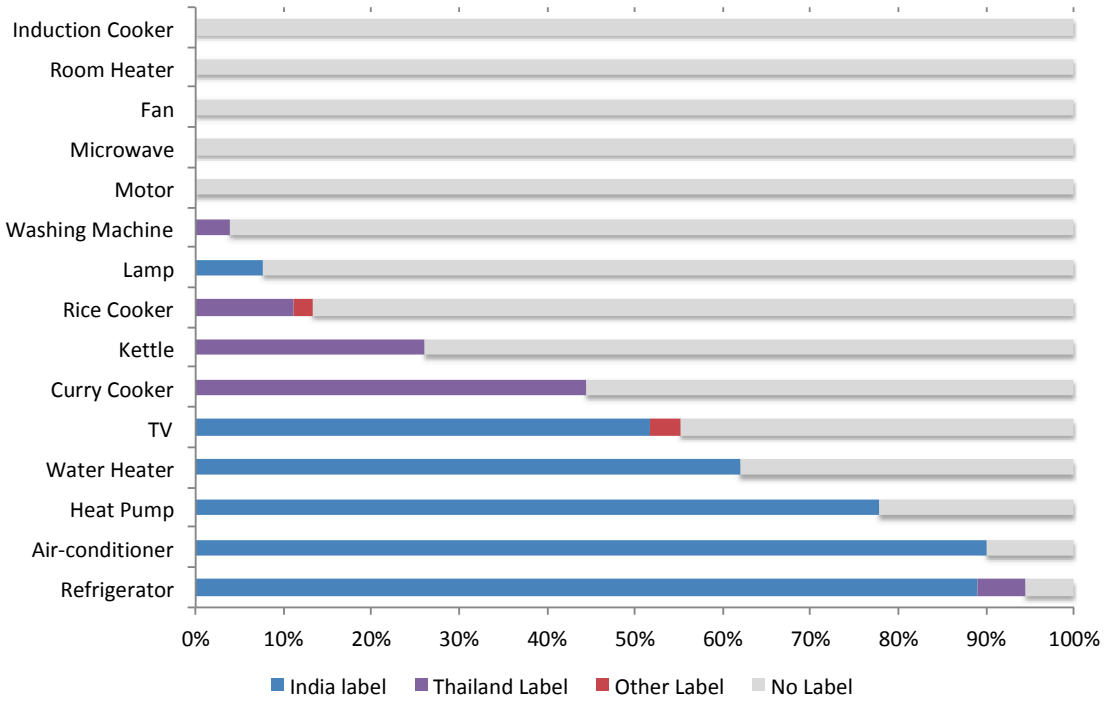


Figure 88 Product categories with labels and types of labels.

The Indian label is present on majority (i.e. more than 50%) of refrigerators, air-conditioners, reversible heat pumps, water heaters and TV in the Bhutanese market. This is because majority of these imports are from India, and these appliances are subject to the mandatory energy labeling schemes invoked in the country.

The Thai label is commonly found on the smaller kitchen appliances such as curry cookers, water boilers, rice cookers, and the labels are not on the majority of appliances (i.e. less than 50%). Even though a large share of these appliances is from Thailand, only the 5-stars products are labeled under the voluntary energy rating scheme in Thailand.

The potential energy savings from the 5 appliances with labels from India amounts to:

Appliance	Potential Savings [MWh/year]	Lifetime Energy Savings [MWh]	% Labeled [%]
Refrigerators	1,308	13,080	90%
Air Conditioners	247	2,473	90%
Reversible Heat Pumps	116	1,159	78%
Storage Water Heaters	459	4,592	62%
Televisions	304	2,435	62%
Total	2,434	23,739	-

Table 88 Energy savings for the appliances labeled with the Indian label.

The potential energy savings from the 5 appliances with labels from Thailand amounts to:

Appliance	Potential Savings [MWh/year]	Lifetime Energy Savings [MWh]	% Labeled [%]
Rice Cookers	780	6,239	11%
Water boilers	496	3,967	26%
Curry Cookers	234	1,872	44%
Total	1,510	12,078	-

Table 89 Energy savings for the appliances labeled with the Thai label.

From the above tables it can be seen that the large appliances that are already labeled with the Indian energy star label has a much larger energy saving potential than the small appliances with the Thai energy star label. Additionally, there are more appliances labeled in the large appliance categories. In addition to the potential savings shown above there are further potential savings for heat pumps if they replace room heaters as there is a potential total lifetime saving of about 61,000 MWh savings, if room heaters are replaced by energy efficient heat pumps in the market.

3.6 Comparison of labels

The Indian and Thai labels are most common in the market. The two label schemes are different in their scope and implementation. The Indian label is mandatory for selected product categories and is updated on a regular basis. The mandatory label is required by law to be displayed on the appliances and products must meet the minimum performance criteria for

achieving 1-star. This means that the 1-star criterion is a de facto minimum energy performance standard (MEPS) except for the LED lamps where 2-star is the MEPS.

Thailand has minimum performance standards for selected products and a voluntary labeling scheme for a large number of products. The labeling focus only on the 3 to 5-stars products and as it is voluntary to display the label, most manufacturers choose to only display labels on products that has achieved a 5-stars energy rating.

The energy rating criteria for the Indian labeling schemes are frequently updated. For example, the criteria for refrigerators are only valid for the period 1/1-2016 to 31/12-2018. The energy rating criteria are improved regularly following the market and technological development. A refrigerator that was rated 5-stars in 2010-11 will only receive 1-star in 2016-18.

The rating criteria for refrigerators in Thailand were updated in 2012 and thus the criteria reflect the market and technological situation at that time. Comparing the rating criteria for the Thai and Indian labeling schemes shows a big difference in criteria for achieving 5-stars. The diagram below shows the differences for direct cool and frost free refrigerators, where a 5-stars refrigerator from Thailand may receive a much lower star rating in India. A 5-stars frost-free refrigerator from Thailand may not even receive 1-star in India, and may not be accepted to enter the market.

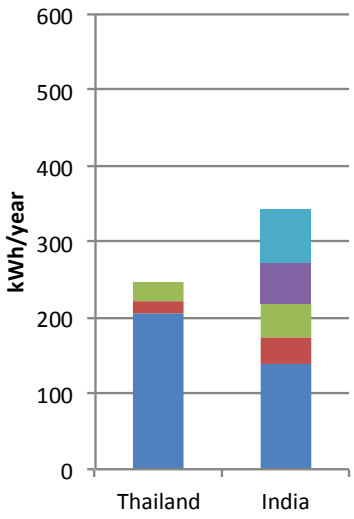


Figure 89 Thai and Indian rating for 200 litre direct cool (1 door) refrigerators.

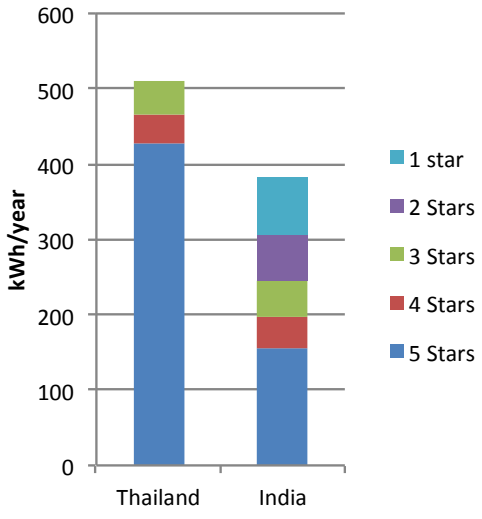


Figure 90 Thai and Indian rating for 200 litre frost-free (2-door) refrigerators.

The mandatory labeling in India has a period of validity, but for some products, such as televisions and storage water heaters the rating criteria have not been updated as of September 2018. This means that the labels are still following the old criteria (e.g. 2017). However, comparing the Thai and Indian labels, the Indian label can be most consistently applied to products in Bhutan, due the mandatory scheme in India and high import rates for especially large home appliances. The Indian rating criteria are also more stringent while also

being a better representative of the performance of the newer appliance models entering the market.

No.	Appliance	India	Thailand
1	Lamps	M (2018-2019/2020)	V
2	Rice Cooker		V
3	Water boiler		V
4	Refrigerator	M (2016-2018)	V
5	Curry Cooker		V
6	Television	M (2016-2017)	V
7	Washing machine	V (under abeyance)	V
8	Room heater		
9	Microwave Oven		V
10	Storage Water Heater (Geyser)	M (2015-2017)	V
11	Fan	V (2016-)	V
12	Reversible Heat Pump	as air conditioner	V
13	Mixer-Grinder		V
14	Air conditioner	M (2018-2019)	V
15	Motor	V (2016-)	V

Table 90 Existing energy rating and labeling schemes in India and Thailand. (M = mandatory, V = voluntary)

3.7 Cost of Energy Labeling

Introducing energy labels are associated with some cost. Apart from developing the rating schemes and standards, there are expenses for the manufacturers for testing the appliances, approval and issuance of labels. Testing can be done in accredited third party laboratories or in-house laboratories in the manufacturers' premises. As only a sample of models (in case of larger equipment, it may only be one) the cost for testing is minimal when large quantities are being sold. However, for most products sold in Bhutan the quantity is relatively low e.g. refrigerators' annual sale is only around 10,000 units spread over more than 70 models. This means that only 100-200 units of each model are sold. If a test has to be carried out for a model that is sold in such a low quantity the testing cost will add to the final retail price. The market volume is therefore important for avoiding additional cost to the final consumer prices.

The label itself also comes with a cost. In India, the cost of registration of a label for refrigerators is Rs. 2,000, while each label is priced at Rs. 5, so again the expected sales volume is important as the registration cost is lower per unit at large quantities.

Currently, all appliances in Bhutan are imported, so in order to implement a labeling scheme in the country, there is a risk that some manufacturers will be reluctant to label their products if the transaction cost is high and the expected sales volume is low. Thus a labeling scheme in the country may benefit from aligning itself with a larger market such as India. Following the Indian labeling scheme will keep transaction costs low for products already in the Indian market. It will also make it more attractive for manufacturers in other countries to label their products for Bhutan, if the test and criteria are the same as for a bigger market such as India.

4 Recommendations

All appliances are imported in the country and a large share of appliances that enters the local retail market displays an energy label, from the country of origin. The survey found that Indian label dominates the local market. The Thai label is commonly found on small kitchen appliances, such as cookers and water boilers, but only the 5-stars label is common, as the Thai labeling scheme is voluntary, and the manufacturers mainly label 5-stars appliances. Therefore, the standards and labeling scheme proposal takes the following factors into consideration:

1. The market for appliances is relatively small due to the small size economy
2. All appliances are imported, mainly from India
3. Many appliances sold in the market are already labeled
4. The energy efficiency level for most appliances are medium to low
5. Electricity prices are low
6. Lack of awareness on energy efficiency among consumers and vendors
7. Limited attention to the energy labels existing in the market

In order to implement energy labeling with the least cost and largest impact, it is recommended to adopt the Indian labels for the appliances that are covered by the mandatory energy labeling scheme in India. As the labels are already in the market, the main task will be to promote the labels to the consumers as well as ensuring that the most energy efficient (i.e. 5-stars) appliances are available in the market and have a competitive pricing. The mandatory labeling in India is a de facto minimum performance standard as products, which do not meet the minimum energy performance requirements are banned. There is a risk that such products that are banned in India may be exported to countries without a labeling scheme, such as Bhutan. Implementing a labeling scheme will therefore control and avoid the import of such products.

The market transformation to more energy efficient appliances is a continuous process, where efficient products will displace the current products gradually depending on the promotion, incentives and awareness of the efficient products. An annual transformation of about 20% share of high energy efficient appliances is a realistic scenario, which is achievable in most economies. The following recommendations for the standards and labeling scheme for selected appliances are a based on this level of ambition.

4.1 Initial Product Focus

The analysis of the 15 products shows that the highest saving potential can be achieved by a market transformation from the current baseline products to the more efficient products for the following three products.

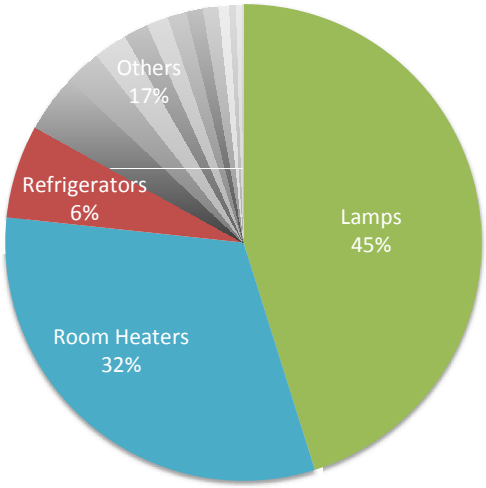


Figure 91 Energy saving potential through market transformation

The energy saving for lamps is derived from transforming the current market, where incandescent, compact fluorescent lamps and fluorescent tube lamps dominate, to LED lamps with significantly higher energy efficiency. For room heaters the transformation from conventional electrical heaters to reversible heat pumps will also improve the energy efficiency dramatically. Finally, refrigerators currently have an average rating of less than 3 stars. Improving this to 5 stars will again provide a high degree of improvement in energy efficiency.

The 3 products are already mandatory under the Indian energy labeling scheme, which means that products imported from India are or will be labeled. However reversible heat pumps are not directly a part of the mandatory labeling scheme in India, but many are labeled as air-conditioners and thus tested for their cooling efficiency, which provides an equally good guidance for the heating efficiency. The three product categories have relatively low cost of energy savings and is well below the socio-economic cost of electricity (i.e. the electricity cost excluding subsidy) as depicted in figure 87. However, the premium cost is still considered a major barrier for wide uptake of the technologies.

Product	Baseline Cost [Nu.]	Average Premium Cost [Nu.]	Premium Cost [%]	Annual Cost Savings [Nu.]	Pay Back Time [Years]
LED Lamps	123	158	128%	64	2.5
Reversible Heat Pumps[12]	46,550	14,004	30%	1,364	10.3
Refrigerators	21,828	5,422	25%	385	14.1

Table 91 Overview of premium cost, savings and payback time for the 3 products.

[12] The cost and savings is based on an average size heat pump with 6 kW heating capacity. This model will displace 3 conventional room heaters of 2 kW heating capacity.

A major barrier for the market transformation is the premium cost for the energy efficient products.

For lamps, the LED lamps cost twice as much as conventional CFL or fluorescent tube lamps, and much more than incandescent bulbs. Although the payback time is reasonable, the upfront cost is causing many consumers to choose the conventional lamps.

Reversible heat pumps have a significantly higher cost compared to conventional room heaters. First, the heating capacity of a typical heat pump is about 3 times higher than a typical conventional room heater. This means that a heat pump shall be considered as an alternative to buying 3 conventional heaters and can heat up a larger area. Second, the payback time is relatively long for the consumers, although it is well within the lifetime of the product.

5-stars refrigerators are about 25% more expensive than the typical 3-stars refrigerators in the market. The payback time is relatively long for the consumer compared to the service life of the product.

4.2 Incentives

The main barrier for the market transformation is the cost of the energy efficient products and the relatively long payback time. As the payback time is the ratio between premium cost and the energy cost savings, there are two elements that can make the products more attractive; the price, and the energy cost savings.

$$\text{Payback Time} = \frac{\text{Premium Cost}}{\text{Energy Cost Savings}}$$

1. Reducing the Premium Cost

The premium cost can be reduced by providing a cash rebate or grant to the consumer, so that the additional cost of the product is brought down to a level that is attractive to the consumer. A rebate does not have to offset the full premium cost, but only enough to make the product feasible to buy for the consumer. A rebate also provides the perception to the consumer that the product is priced below its real market value, which makes it more attractive to buy. A rebate or grant requires a capital outlay by the government or from a funding agency.

Providing a tax reduction or exemption for energy efficient products can also reduce the premium cost. This incentive will make the products cheaper to import and affect the final retail price. For reversible heat pumps, a tax exemption will also ensure that there is a level playing field between conventional room heaters and heat pumps as room heaters are currently exempted from sales tax and import duty. Exempting import duty will allow a wider range of products to enter the market, as it becomes cheaper to import products of third country origin.

Finally, the premium cost can also be reduced by increasing the tax for conventional products, while keeping the energy efficient products at the current tax rate. For instance, conventional room heaters could be subject to a higher tax rate than reversible heat pumps, making these products more expensive and thus reducing the premium cost gap. Similarly, conventional lamps i.e. incandescent bulbs, CFL, fluorescent tubes could be subject to higher sales tax and import duty than LED lamps.

However, increasing the tax for conventional and commonly used products such as room heaters may make the products expensive for the general public.

Nevertheless, imposing higher tax and duties on products which are highly inefficient, such as the incandescent lamps, which also have suitable alternatives (LED lamps, etc.) may be a strategic move by the Government.

2. Increasing the Energy Cost Savings

The energy cost saving is a result of the energy savings and the electricity price. As the electricity price is subsidised and below the real market price, an increase in electricity price will reduce the subsidy and increase the government revenue. At higher electricity cost, the value of the energy savings will be higher and the payback time reduced. However, increasing the electricity price may be considered a general burden to the consumers and have a negative perception by the public.

Of the various incentives, the reduction of sales tax and import duty will have the least adverse effects on the public and the economy, as it will not increase the baseline cost of products and electricity. The incentives are directly targeted at the energy efficient products in order to make them more attractive for the importers to import and reduce the retail price. Alternatively, a cash rebate funded independently is also a manageable incentive, which can be directly applied to products, which are to be promoted.

As electricity is subsidised, the value of the electricity cost savings are relatively low and thus it is necessary to support the energy efficient products to create a level playing field between saving electricity and consuming electricity. Any support provided to energy efficiency will provide a saving in the subsidy to electricity, which justifies the incentives to energy efficient products.

4.3 Tax Incentive Modalities

Tax incentives such as sales tax and import duty exemption can be provided as a general exemption by changing the current tariff rates to lower or zero rates for energy efficient products. For LED lamps and reversible heat pumps, this is relative simple, as they are categorised with their own tariff codes. For refrigerators, it will be necessary to create a new and separate tariff code for 5-stars refrigerators, which will have its own sales tax and import duty rates.

The incentive can also be provided as a tax and duty waiver for the import of the identified products. A tax waiver can be given upon prior application by the importer for the energy efficient products and be used to waive off the prevailing taxes and duties upon point of entry to the country.

A tax and duty waiver should be accorded for a fixed period, and should be discontinued at the end of that period, subject to an assessment of the programme in terms of its intended impact and possibility of sustaining the impact on withdrawal of the waivers.

4.4 Public Procurement

The public sector is a major consumer and buyer of equipment and appliances and plays a major role in creating a demand for energy efficient products. There are already provisions for including green procurement and energy efficiency in the procurement guidelines, and the energy labeling will make it easier to specify the requirement for energy efficiency in the technical specifications[13] for the procurement.

Bhutan Standards Bureau has developed a certification scheme for approved brands and vendors for public projects. For electrical products the certification covers LED lamps, storage water heaters and fans among others, which could be further certified in terms of energy efficiency. The BSB certification at present is mostly concerning conformity with relevant product standards in terms of quality and safety and does not focus on the energy efficiency on the products. The certification could, be extended to also incorporate energy performance of the equipment, as specified by relevant authority to ensure that public procurement is taking energy efficiency into account when selecting a certified brand and vendor.

4.5 Refrigerators

The survey showed that 90% of refrigerators sold in the market carried the Indian label but only one model was 5-stars rated. A labeling scheme for refrigerators must focus on getting more 5-stars rated appliances into the market by encouraging importers to bring the stock into the country. Currently, there are 49 models of refrigerators, which are registered as 5-stars with BEE in India as shown in the figure below. These are 1-door direct cool types and the 2-doors frost-free types. The scheme should aim to bring some of these models into the local market and encourage the consumers to purchase them over the lower rated models.

[13] Energy efficient appliances and equipment can be specified by procuring agency under the technical specifications as per Section 6 of the Procurement Rules and Regulations 2009

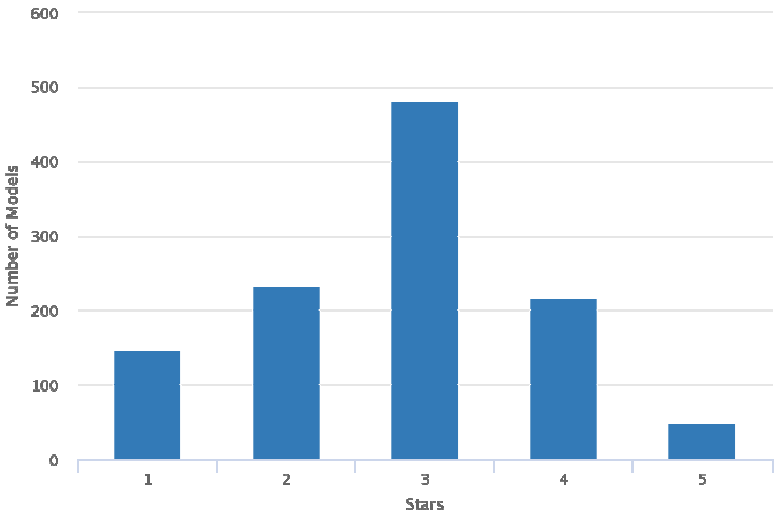


Figure 92: Star ratings and number of labeled direct cool and frost-free refrigerators in India (Source: BEE)

As the premium cost is high for 5-stars refrigerators compared to lower efficiency models, some ways to reduce the marginal cost must be considered, so that the cost difference gets smaller and the payback time is reduced. Thus, the scheme may explore to introduce some incentives to promote 5-star products in the domestic market.

Rebate scheme

Tax Rebate: At present, Royal Government of Bhutan imposes 5% sales tax and 20% import duty on the refrigerators. The import duty is not applicable for the goods imported from India. Most of the refrigerators available in the domestic market are imported from India. To encourage the energy efficient refrigerator entering into the market, as an alternative, RGoB can consider waiving the taxes on the import of refrigerator. Introduction of a waiver on sales tax will have short-term and long-term impacts to the national revenue, but a waiver of import duty from third countries will have a very minimal impact, as import will be diverted from India, where it is currently import duty free, to other countries. However, making it more attractive to import from third countries will make it easier for importers to source the highest efficient appliances irrespective of the country of origin.

Cash Rebate: To kick start the market transformation and create interest for the importers and retailers to stock 5-stars rated refrigerators and for the consumers to purchase the models, a rebate can be given for a limited number of refrigerators. This incentive scheme has been successfully implemented in Denmark and Malaysia to introduce 5-star models in the market and initiate the market transformation. A cash rebate given to only 5-star models works as a special discount which will entice the customers to choose the 5-star products over the conventional products. It is proposed to offer the rebate for a limited number of units, for example, 10% of the annual sale of products, which would be around 1,200 units. It can be offered as a sales discount at the point of sale by the retailers, so the customers are given an instant rebate on the product. Introducing the cash rebate for 1,200 units, the government will have additional financial burden as expressed in table 92. From the energy savings, the direct

financial gain to the customers is in table 93. The government can consider sharing portion of this gain to promote higher energy efficiency (5-stars) refrigerators in the market.

The rebate is expected to boost short-term sale of 5-star products in the market. The total sale of products may even be higher than usual for the period. When the rebate funds are exhausted, the sale is likely to drop below the normal average, but will eventually normalize and 5-star models will continue to be sold, as they are available in the market, and the retailers will continue to promote the models as well as they become subject to the normal market competition between retailers. The rebate scheme may bring positive impact to the market. If the rebate scheme is provided for 1,200 units (10% of the market share), the anticipated sale of 5-stars models may increase to about 2,400 units as shown in the below figure, which would be about 20% of the total annual market.

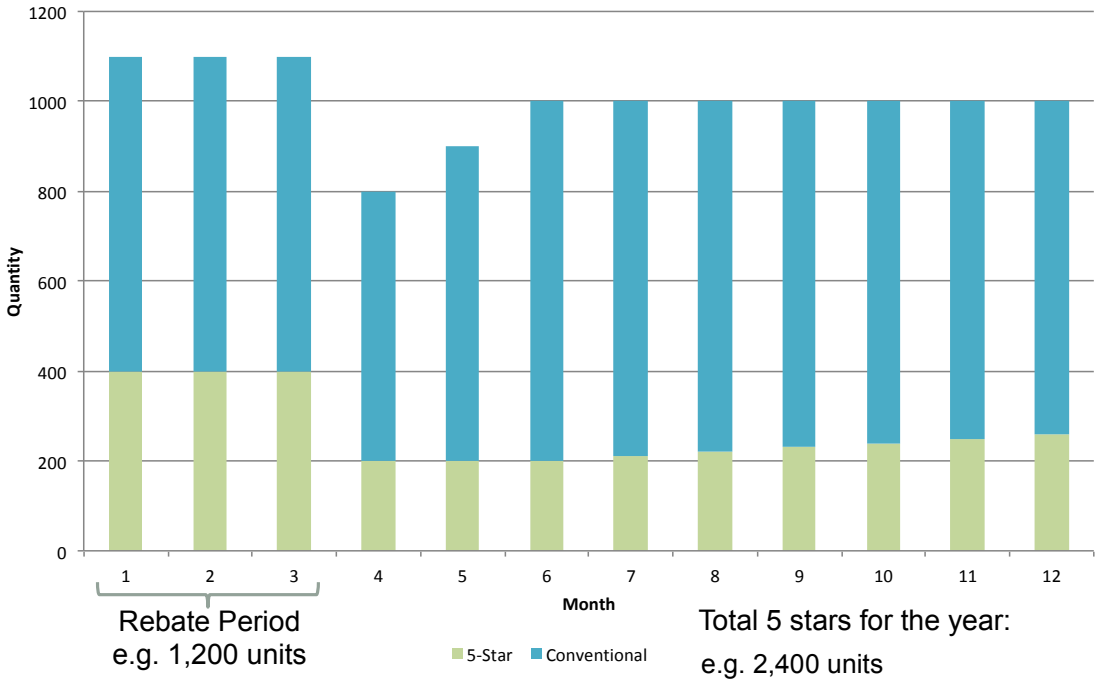


Figure 93 The cash rebate is only given to a limited number of products in a short introduction period, but will result in additional sale of 5-stars products in the subsequent period after introduction.

Advertising and Promotion (A&P)

The benefits of energy efficient appliances must be advertised and promoted to the consumers through educative awareness campaign. The consumers must be well informed about the label, the benefits in terms of cost savings, and benefits to the environment. As the label makes the promoted products visible in the market, the consumers will be able to identify the products easily, however they will need to know the details of the label and that the most energy efficient product is the 5-stars rated product. This can be informed to the consumers by general advertising through mass media e.g. TV, radio and newspapers. In addition, more detailed advertising and information should be made available in the retail outlets, in the form of leaflets and point of sale material that focus the attention of the 5-stars

products, for instance additional stickers or banners for the 5-stars models in the outlet. Retailers must also be educated about the energy star labels and the overall cost and environmental benefits to consumers. This can be achieved through targeted workshops and trainings for retailers.

Information should also be provided on a dedicated web site for the label. This web site can contain general information of the label and how to read the information and explanation of the benefits. In addition, the web site should include a database of the specific 5-stars rated appliances available in the market. This requires close cooperation with the importers and distributors, as they will need to inform about the models they bring into the country. The rebate programme and sales tax exemption described above will require that the importers and distributors inform the government about the specific models and this information can be used for maintaining and updating the database.

Costs and benefits

The promotional cost of the refrigerator programme includes the cost of providing rebates for a limited number of refrigerators. The rebate is equal to the premium cost for 5-stars refrigerators. Providing a sales tax exemption will result in foregone tax revenue of the 5% on every 5-stars unit imported. The foregone revenue is based on the expected market share for 5-stars refrigerators in the first year. The advertising and promotion will include cost for design of campaign material, printing and distribution. This also includes fund for broadcasting, etc. The A&P budget is based on an assumption that some costs are shared with the other appliances to be promoted in the year.

Preliminary budget for the first year of programme implementation is based on a target of transforming 20% of the market to 5-star refrigerators i.e. 2,400 units in the first year of implementation.

Item	Units	Cost per unit [Nu]	Total Cost [Nu]
Rebates	1,200	5,500	6,600,000
Foregone Sales Tax (5-stars)	2,400	820[14]	2,000,000
A&P Cost	2,400	1,000[15]	2,400,000
		Total Cost	**11.0 Million**

Table 92 Estimation of cost for refrigerator campaign in the first year.

The direct savings in the first year will be the socio economic savings in terms of saved electricity generation and the associated subsidy for electricity supply.

[14] The average import value of refrigerators is assumed to be 75% of the retail price of the baseline type refrigerator. Sales tax rate is 5%.
[15] A&P cost are roughly estimated to be Nu. 1,000 per unit promoted.

Item	Units [Nos]	Lifetime Saving per unit [kWh]	Total Energy Savings [MWh]	Saving per unit [Nu/kWh]	Total Savings [Nu]
Direct Electricity Cost Saving	2,400	1,100	2,640	3.53	9.3 Million
Subsidy Saving	2,400	1,100	2,640	2.29	6.0 Million
				Total Savings	**15.3 Million**

Table 93 Estimation of benefits from the first year of the refrigerator campaign

4.6 Reversible Heat Pumps Heat Pumps and Air-conditioners

Although the market for air-conditioners and heat pumps is small at present, it is expected that these appliances may increase in the future as the household income grows as well as more commercial buildings install these appliances (e.g. hotels, offices, shops etc.). Especially reversible heat pumps should be promoted, as they can replace the market for conventional electrical room heaters. They are 3-5 times more energy efficient in converting electricity to heat and can provide very large savings for room heating. The standards and labels can help to identify the most energy efficient models, and at the same time promote heat pumps to be used instead of conventional room heaters.

The use of heat pumps for room heating can also provide savings of biomass fuels and fossil fuels, as it can replace wood and LPG fired ovens and stoves, so the technology can alleviate the depletion of forest and import of petroleum fuels. In addition, it can improve the indoor air quality of homes.

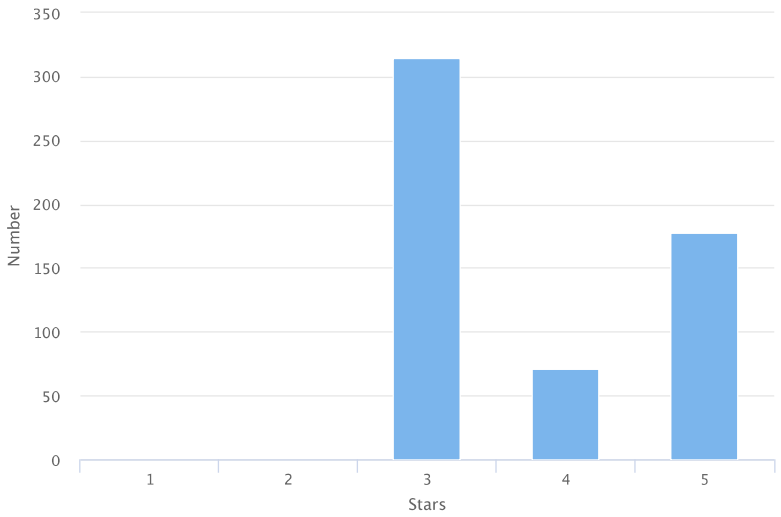


Figure 94 Star ratings and number of models for inverter type air conditioners in India (Source: BEE)

The figure above shows 178 5-stars, inverter type air conditioners registered in the BEE database in India. Some of these are also reversible heat pumps with both cooling and heating capacity, while the majority is only air-conditioners for cooling.

Incentive Scheme

The premium cost for air-conditioners is found to be around 8%, while it is around 30% for heat pumps. The big difference in premium is very likely due to the large number of 5-stars air conditioners in the market and the small number of reversible heat pumps. As the technology is similar, it can be assumed that premium for 5-star heat pumps will be reduced as more models enter the market.

The premium cost for heat pumps compared to conventional room heaters is very high, about 3-4 times higher. However, it is difficult to directly compare a heat pump with a radiator type room heater, as the heat pump is a much more advanced heating device, which can provide a better comfort for a larger living area due to the circulation of air. One heat pump is often able to substitute 2-3 radiators in a living room. Conventional room heaters are not subject to sales tax and import duty, while heat pumps and air-conditioners are imposed a sales tax of 5% and import duty of 20%.

The suitable incentive to promote air-conditioners and heat pumps would be to introduce a "Finance Scheme" as the capital requirement is high (Nu. 40,000-70,000 per unit as per current market). A finance scheme will reduce the capital cost burden and spread the payments over a period of time. It is important to take into consideration that the appliance will provide energy cost savings to the customer, so these savings cover a part of the instalment payment. The actual design of a finance scheme should be made in collaboration with commercial finance institutions, and it could be in the form of a loan or leasing contracts or hire-purchase contracts, where the appliance is owned by the finance institution during the contract period and then handed over to the customer by the end of the contract period, which could be 24-36 months. This will reduce the risk for the bank as they have a collateral in the appliance. It could also be an extension of a housing loan or a personal loan at a reduced rate with a pledge in the equipment.

The finance could also be backed by a government credit facility, where the government provides credit guarantees for the outstanding loan amounts and the banks in return provide a lower interest rate on the loans due to the reduced risk. The electricity distribution company could also provide finance, where the payments are collected through the monthly electricity bill. However, this may require some changes to the scope of activities that the distribution company is allowed to perform.

Most air conditioners and heat pumps are imported from India where only 5% sales tax is applicable. In order to reduce the premium for 5-stars models the sales tax should be exempted. This will bring the 5-stars air conditioners almost on par with the lower rated models in terms of cost. For heat pumps it should be considered to waive off the sales tax for either the 5-stars models or for energy star rated models, as even lower rated models will provide significant savings compared to the conventional room heaters. The decision can be taken at a later stage after further studies on available heat pumps in the market have been completed. As heat pumps are more used in colder climates, it is expected that higher energy efficiency models may be available in other countries like Japan, South Korea, etc. Thus, it may

be prudent to consider exempting of import duty on heat pumps. The impact of removing the import duty is minimal, as the import will substitute an import of room heaters, which are currently exempted from sales tax and import duty. At present the majority of room heaters are imported from China, whereas heat pumps are expected sourced in India and other countries that manufacture heat pumps. Most reversible heat pumps are from the same manufacturers that produces air-conditioners e.g. Blue Star, Daikin, Panasonic, Sharp etc.

Advertising and Promotion (A&P)

The A&P for air conditioners must focus on promoting the 5-stars air-conditioners over the lower rated models. The focus of the A&P should also be on the benefits of installing heat pumps instead of conventional room heaters, as there is a large sale of room heaters at present. Although the 5-stars heat pump is the most efficient type, there will still be considerable saving if a 3 or 4 stars model is used instead. Thus the campaign should create awareness about the higher efficiency of heat pumps compared to room heaters and the additional improvements in comfort, etc. It would be beneficial to demonstrate and show case the heat pump technology in some of the places where heat pumps are currently installed e.g. commercial buildings such as hotels, restaurants and shops. It will also be good to have some of the main retailer outlets to have demo-units in the shops, where customers can see how the technology works.

The 5-stars label website described above should also present the benefits of heat pumps as well as a database of available models providing an overview to the public about which sizes and types are available in the market.

Costs and benefits

Providing a sales tax exemption will result in foregone tax revenue of the 5% on every 5-stars unit imported. The foregone revenue is based on the expected market share of 20% for 5-stars air conditioners and reversible heat pumps in the first year. The advertising and promotion will be a budget for design of campaign material, printing and distribution. This also includes funds for broadcasting etc. The A&P budget is based on an assumption that some costs are shared with the other appliances to be promoted in the year. Preliminary budget for the 1st year of programme implementation is shown in table 94.

Item	Units	Cost per unit [Nu]	Total Cost [Nu]
Foregone Sales Tax (room heaters)	2,360	0	0
A&P Cost	2,930	1,000[16]	3.0 Million
	Total Cost	**3.0 Million**	

Table 94 Estimation of cost for the first year of the heating and air conditioning campaign.

[16] A&P cost are roughly estimated to be Nu. 1,000 per unit.

The direct savings in the first year will be the socio economic savings in terms of saved electricity generation and the associated subsidy for electricity supply.

Item	Units [Nos]	Lifetime Saving per unit [kWh]	Total Savings [MWh]	Saving per unit [Nu/kWh]	Total Savings [Nu]
Direct Electricity Cost Saving (Room Heaters)	2,360	5,585	13,200	3.53	46.5 Million
Direct Electricity Cost Saving (Air Conditioners)	500	1,214	610	3.53	2.2 Million
Direct Electricity Cost Saving (Heat Pumps)	70	3,877	290	3.53	1.0 Million
Subsidy Saving	2,930	-	14,060	2.29	32 Million
				Total Savings	**81.8 Million**

Table 95 Estimation of benefits from the first year of the heating and air conditioning campaign.

4.7 Lamps

The largest potential for energy savings is by replacing conventional incandescent and fluorescent lamps with LED lamps. DRE has already implemented programmes to promote LED lamps, and with the price reductions on LED lamps that the World market has experienced over the recent years, this is a highly feasible conversion. Promotion and awareness of LED lamps should be continued. The energy labeling in India of LED lamps can be a tool to promote LED lamps. Although the need for the label is not crucial since the LED technology is more efficient than any conventional lamp, an energy label will however, ensure that the lamps have been tested and the performances have been certified under appropriate standards. As the Indian energy star label for LED lamps has become mandatory it is expected that more lamps in the market will display the label in the near future. A labeling scheme for Bhutan should ensure that the LED lamps that enter the market are labeled and a general promotion of LED should be continued.

An additional effort should be made to make LED tubes available in the market. The only common type of LED tubes found in the market is a complete luminaire, which will replace the entire conventional FTL (luminaire and lamp). This can be more expensive for existing building requiring retrofit lamps. Using LED retrofit tubes in existing luminaires either directly or with a simple rewiring, depending on the luminaire type can make retrofit projects more feasible.

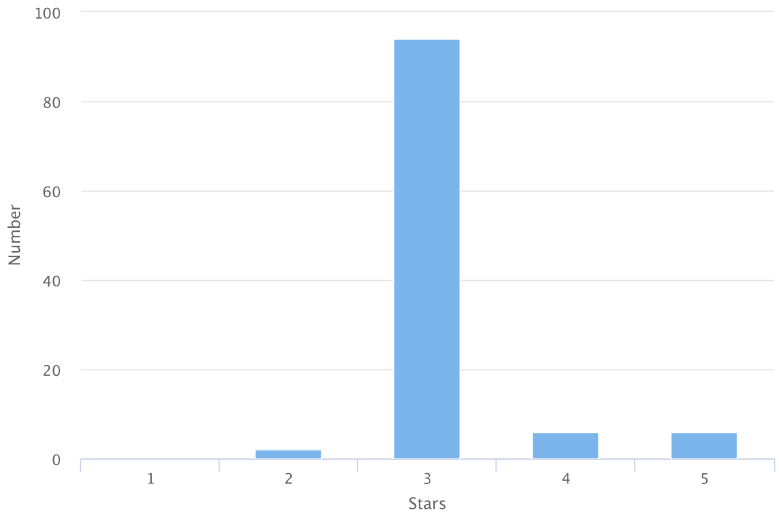


Figure 95 Star ratings and number of LED lamp models in India (Source: BEE)

Incentives

To further push the market for LED lamps it should be considered to exempt the LED lamps and luminaires from import duties and sales tax. Currently there is a sales tax of 10% on import from all countries and 20% import duty for imports from countries other than India. Removing the sales tax of 10% will have a significant impact on the premium cost for LED and they will in many cases be almost priced at the same level as CFL lamps. Removing import duties will attract imports from third countries, where the latest LED technology may be developed such as Europe, Japan and South Korea.

Costs and benefits

A total of 720 Million lamps were imported in 2017. The major share came from India (710,000 lamps), while only 8,200 came from other countries. The total import from both India and third countries amounted to Nu. 72.5 Million in 2017, where 66 Million derived from import from India. The total sales tax revenue was Nu. 7.25 Million in 2017 – or about Nu. 10 per lamp.

The import value from third countries only amounted to Nu. 6.5 Million in 2017. The total imposed import duty was therefore around Nu. 1.3 Million or about Nu. 160 per lamp. The lamps from third countries carry a high import value of almost Nu. 800 per lamp on average, as opposed to the average value of Nu. 90 for lamps from India, which could be because only some special lamps are imported from other countries than India. The market transformation is therefore mainly for lamps from India, as these are more traditional lamp types.

The advertising and promotion will be a budget for design of campaign material, printing and distribution. This also includes fund for broadcasting, etc. The A&P budget is based on an assumption that some costs are shared with the other appliances to be promoted in the year.

The preliminary budget estimate for the first year of programme implementation is based on a market transformation of 20% of the market in 2019:

Item	Units	Cost per unit [Nu]	Total Cost [Nu]
Foregone Sales Tax	100,000	10	1,000,000
A&P Cost	100,000	20[17]	2,000,000
		Total Cost	**3.0 Million**

Table 96 Estimated cost of the LED campaign in the first year.

The direct savings in the first year will be the socio economic savings in terms of saved electricity generation and the associated subsidy for electricity supply.

Item	Units [Nos]	Lifetime Saving per unit [kWh]	Total Energy Savings [MWh]	Saving per unit [Nu/kWh]	Total Savings [Nu]
Direct Electricity Cost Saving	100,000	186	18,600	3.53	65.7 Million
Subsidy Saving	100,000	186	18,600	2.29	42.6 Million
				Total Savings	**108 Million**

Table 97 Estimated benefits of the first year LED campaign.

4.8 Future Campaigns

As the mandatory energy labeling in India also includes storage water heater and TVs, it will be natural to follow up the promotion of energy labeling with these two products after the first three campaigns have been implemented.

Many storage water heaters in the market are already labelled and most of them are 4 and 5 stars. The potential energy savings from labels are relatively small because of the high energy efficiency level. However, the labels are important to ensure that the products in the market remain energy efficient and also to provide information to the consumers to compare the water heaters' energy consumption, as these appliances have major contribution to the monthly electricity bill.

[17] A&P cost are roughly estimated to be Nu. 20 per unit promoted.

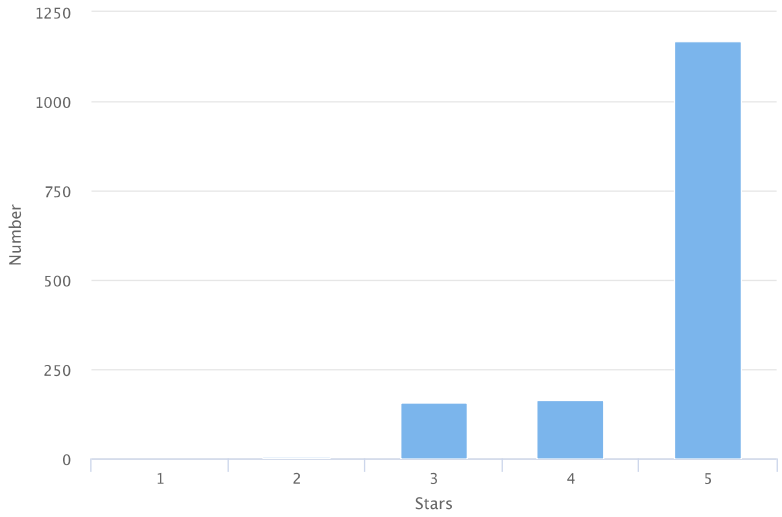


Figure 96 Star ratings and number of storage water heater models in India (Source: BEE)

It is proposed to include the promotion of the 5-stars water heaters on the 5-stars web site, so the models available in the market are available in online database. It is also recommended to keep check the market regularly to ensure that the models remain high efficient. In the case that country of origin, i.e., India increases the criteria for 5-stars water heaters, it would become relevant to design a promotion campaign and consider incentives based on the revised energy rating criteria. General information about storage water heaters should be included in the web portal as well as a database of 5-stars labeled models in the market.

About 50% of televisions in the market are labeled, and it is found that the payback period is about 80 years for 5-stars TVs. The energy cost saving is very small and it may be difficult to encourage consumers to select TVs based on a high star rating, as they may be more attentive to features, picture quality etc. rather than the energy consumption.

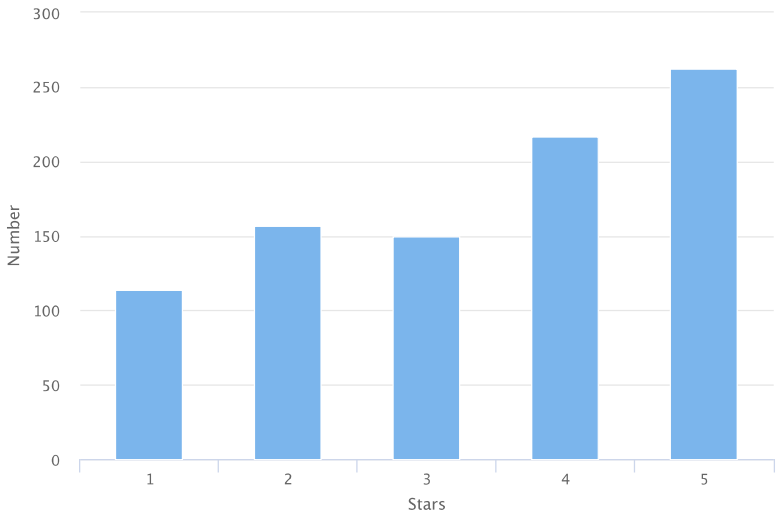


Figure 97 Star ratings and number of TV models available in India (Source: BEE)

As TVs are labeled in India, Bhutan can still adopt the label and increase awareness about the energy consumption of TVs, however as the potential energy savings are small, the effort

should be limited to awareness initially. Thus no detailed assessment of the cost and benefits has been carried out.

4.9 Overall Recommendations

The above recommendations for the activities in the short term can be summarised as follows:

Development of the standards and labeling scheme

To initiate the standards and labeling scheme, the Indian energy label may be recognised by the Royal Government to be included in the national standardization and certification schemes and followed up by the energy rating criteria and energy efficiency standards for the appliances. These can be directly adopted from the BEE's S&L schemes or other international schemes where energy star labels are designed and the performance tests are carried out in accordance with the respective standards recognized and adopted for the purpose.

Voluntary Labeling of Appliances

The introduction of the labels should initially be voluntary, as this will not require new regulations, as opposed to mandatory labeling. As many appliances are already labeled with the Indian label, the voluntary labeling is already taking place, however this should be further followed up with market monitoring and surveillance to ensure that labeled products are labeled in accordance with the government promotion of labels i.e. that the labels are authentic and in particular that the label is within its validity period.

With the government support and promotion of energy performance labels to the public it is envisaged that the suppliers and retailers will be interested in promoting the labels as well, in order to drive their sales of energy efficient appliances, as this may increase their revenues.

Government Support

The market transformation towards higher energy efficiency requires support in order to increase the sale of 5-star appliances. The support must transform the supply side, so suppliers are importing and retailers are stocking 5-star appliances. At the same time, the demand side must be transformed so more consumers are purchasing the 5-star appliances.

The proposed incentives are a mix of tax and duty exemptions, which will increase the market share of imported energy efficient appliances and also reduce the retail price. In addition, in the case of refrigerators, it is proposed to kick start the promotion with a rebate scheme for refrigerators with the highest energy efficiency (5-stars).

Advertising, promotion and information activities in the form of online information, brochures, point of sale material, advertisements, etc. are required for each type of appliances.

The table below summarizes the cost of implementing the labeling scheme, which requires a direct funding of Nu. 7.4 Million for A&P and additional Nu. 6.6 Million in providing cash rebates for refrigerators. The indirect fiscal incentives amount to Nu. 3 Million. In total the cost will be around Nu. 17 Million in the first year of implementation.

Appliance	A&P [Million Nu.]	Rebates [Million Nu.]	Sales Tax Exemption [Million Nu.]	Total [Million Nu.]
Lamps	2	-	1.0	3.0
Refrigerators	2.4	6.6	2.0	11.0
Heating (replacing room heaters with heat pumps)	3	-	0	3.0
Total	**7.4**	**6.6**	**3**	**17**

Table 98 Total cost for the selected appliances and campaigns.

National Benefits

The benefits of the labeling scheme will be significant in terms of energy savings. The energy savings will occur over the lifetime of the appliances and save electricity cost for consumers as well as subsidies provided to electricity supply. A total of almost 35 GWh of electricity will be saved, amounting to more a national cost saving of about Nu. 200 Million in total savings (electricity cost savings and subsidy savings). Thus the savings are about 10 times more than the costs.

Benefits	5-star units [Number]	Lifetime Energy Savings [MWh]	Saved Electricity Costs [Million Nu.]	Saved Subsidy [Million Nu.]	Total Savings [Million Nu.]
Lamps	100,000	18,800	66.4	43.1	109.4
Refrigerators	2,400	2,670	9.4	6.1	15.5
Heating	2,360	13,160	46.5	30.1	76.6
Total	**104,760**	**34,630**	**122**	**79**	**202**

Table 99 Total national benefits for the selected appliances and campaigns.

Government Procurement

A government procurement policy of buying energy efficient appliances will further drive the increase in demand for energy efficient products. The existing procurement mechanism should incorporate the 5-star rated appliances requirements whenever such products are available within the existing national certification scheme operated by the BSB. This should be implemented for both one-off purchases and government tenders. For products without any

labels a request for information about energy efficiency specifications as well as a preference for higher efficiency should be made in request for quotations, etc.

Future Market Transformation

It is assumed that a realistic market transformation that can be achieved with the proposed incentives and promotion activities is about 20% annual market increase for 5-star appliances. This is a realistic market transformation and the basis for the assessment in the previous sections. With a gradual market transformation, the 5-star appliances will increase its market share by 20% per year, so there will be 20% in the first year and 40% in the second year, and so forth. With a continued support and effort in the next 5-year period it is expected that a full market transformation is possible. Full market transformation may still result in some sale of lower efficient appliances for special purposes such as lamps for dedicated industrial purposes, refrigerators for laboratories, clean room heaters and air conditioners etc.

The maximum achievable market share is assumed to be around 90% allowing room for some models to be sold, which are not 5-star labeled. This can be special purpose appliances or appliances of sizes or types that does not fall under the labeling scheme's size ranges etc.

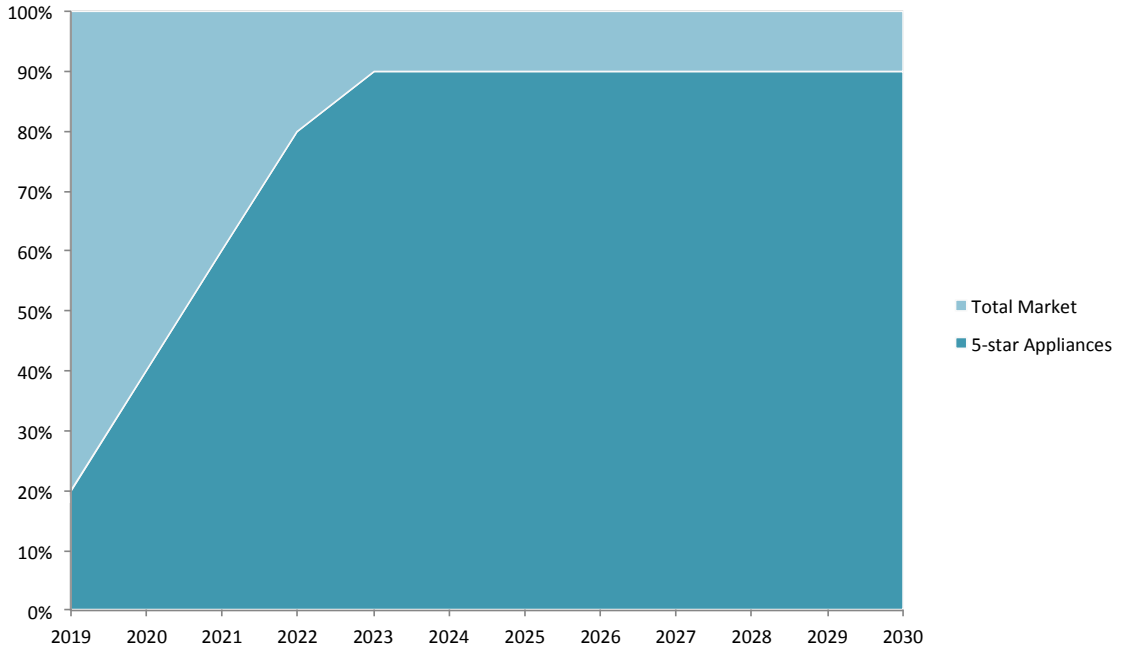


Figure 98 potential targets for the market transformation for 5-stars appliances (based on the 2018 rating criteria)

Over a 5-year period the transformation reaches the 90% saturation, which is based on a 5-star rating as of present. However, as the rating criteria is revised in the future a 5-star rating of today may only lead to a 3-star rating in the year, 2023. So the process of market transformation is continuously changing towards even higher standards than the 5-star ratings of today.