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Communication

Standards and Labeling program for refrigerators: Comparing India with others

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HIGHLIGHTS

- India's minimum energy performance standards (MEPS) for refrigerators high.
- The allowable range of consumption within label large resulting in their dilution.
- Highest efficiency rating for refrigerators in India lags behind other countries.
- Aggressive tightening of Standards and Labeling is proposed for India.

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ABSTRACT

Energy efficiency levels for the Standards and Labeling (S&L) program in India for frost free (FF) refrigerators are compared with similar programs in China, United States of America (USA), and European Union (EU). A normalization method developed by International Energy Agency (IEA) is adopted with India as a benchmark for comparison. It is observed that the energy consumption level corresponding to minimum energy performance standard (MEPS) is very high in India. India also lags behind other countries on the consumption level corresponding to highest efficiency rating. Also, the range of consumption levels corresponding to a label is wide which dilutes the efficacy of label. India has aggressively proposed to tighten the ratings for FF refrigerators in 2014 by 36% across all the bands. This measure will make its highest efficiency rating comparable to other countries. However, due to the wide gap in the consumption levels across the ratings, the revised MEPS will still lag behind other countries. One possible outcome of high MEPS is that as the ratings are tightened, the market may move to lower star rated models significantly undermining the tightening effect.

1. Introduction

Standards and Labeling (S&L) for appliances is a widely used policy instrument to improve energy efficiency of appliances. Standards set the minimum energy efficiency levels of appliances that can be sold in the market. They are commonly called minimum energy performance standard (MEPS). Labels rate the appliances based to their energy efficiency and help consumers make informed decisions on their purchase. In combination, S&L improves the energy efficiency of the appliances in the market by eliminating the most in-efficient appliances through MEPS and promoting the most efficient ones through labels. The Bureau of Energy Efficiency (BEE) has been running S&L program for different appliances since 2006 in India. The labels in the form of star rating (more the stars, more the efficiency) have become popular among Indian consumers influencing them on buying energy efficient appliances. However, the energy efficiency levels corresponding to the MEPS and labels have been generally low. Increasing these levels has a potential of further improving energy efficiency of appliances in Indian market and subsequently saving significant amount of electricity. The focus of this paper is on refrigerators.

Refrigerators consume about 14% of total electricity in residential sector in India and rank third in the total consumption after lighting and ceiling fans (Boegle et al., 2008). However, the penetration of refrigerators in Indian households is still low; only about 8% of rural households and 41% of urban households own a refrigerator (NSSO, 2010). The low penetration and rising income levels are leading to high sales of refrigerators in India. Around 8.4 million refrigerators were sold in India in 2010–11 registering an annual growth of 15% (TVVeopar, 2012). A significant amount of electricity can be saved if these new refrigerators are energy efficient. There is a wide gap in efficiency of refrigerators available in India and those available in international markets. There are a number of options such as better insulation, high-efficiency compressors and higher heat exchange

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efficiency that can reduce the electricity consumption of refrigerators. Approximately 50–70% efficiency improvement is possible over the most efficient models available in India (Chunekar et al., 2011; ICF, 2012). Hence, there is a strong case to adopt measures to improve energy efficiency of refrigerators in India, one of them being an aggressive S&L program.

In this paper, the energy efficiency levels for the S&L program in India for refrigerators are compared with similar programs in China, United States of America (USA), and European Union (EU) on their stringency and efficacy. The testing procedure to measure the energy consumption of a refrigerator varies across countries and hence the measured values cannot be compared directly. These values should be normalized to be compared. A normalization method developed by the International Energy Agency (IEA) (IEA, 2010) has been used in this analysis. The normalized values are then compared based on three metrics: (a) Current MEPS and its proposed tightening (b) range of ratings, and (c) Current most efficient rating label and its proposed tightening.

2. Methodology

2.1. Standard methodology to identify energy efficiency of refrigerator

The energy efficiency of a refrigerator is identified by comparing laboratory measured annual unit energy consumption (UEC) of a model to comparative energy consumption (*CEC*). The testing procedure to measure UEC of a refrigerator is broadly similar across different countries. A typical testing procedure can be described in following steps (IEA, 2010):

1. A refrigerator is placed in a temperature controlled environment, switched on and allowed to stabilize.
2. The refrigerator is than operated for one or more time periods such that the time period covers a normal operational cycle and the energy consumption of electricity is measured. This is usually a 24 hour period.
3. The measured energy consumption is then used to estimate annual energy consumption i.e. the UEC of the refrigerator.

The UEC is then compared to the *CEC* to identify the energy efficiency of refrigerator. The *CEC* is the indicative annual energy consumption corresponding to a particular efficiency level. For instance, if the UEC of a 250 l Frost Free model with 50 l freezer in India is less than *CEC* of 329 kW h, then it is rated as 5 stars. The *CEC* is given as a function of pre-specified constants for different efficiency levels, external and internal temperatures, net storage volume, volume of freezer compartments, and presence of features like ice-making units. The details of this method are described in Appendix 1.

2.2. Normalization method

Although the procedure for measurement of energy efficiency is broadly similar, there are number of factors that can result in variation in the results across different countries. The most important factor is the specification for the ambient temperature of the testing room as well as internal temperature of refrigerator compartments. If the specification for the ambient testing temperature is high, the refrigerator will require more cooling and hence consume more energy as compared to a procedure that sets lower values for the ambient temperature. Apart from the temperature settings, there are other factors that can affect the energy consumption measurement: the presence and the position of the load in refrigerator, the specific procedures for accounting de-frost, use of ancillary features like ice-makers, tolerances, opening of doors during operation and others.

In this analysis, a normalization method developed by the Internal Energy Agency (IEA, 2012) is adopted for India. The method accounts for the variation due to the most important factor, the temperature specifications. The energy used by the refrigerator is directly related to the difference between internal compartment temperatures and external (ambient) temperature. According to the empirical analysis done by experts from IEA, the change in energy required to cool the refrigerator is approximately 3% for every 1 °C change in the differential between internal and external test temperatures. For example, if the differential temperature is 1 °C greater in test method A compared with test method B, then to be comparable, the energy consumed in test method A must be reduced by 3%. However, as discussed previously, different compartments of a refrigerator operate at different temperatures. Different test methods may have different specifications for internal compartments. Hence, the normalization is conducted at compartment level. The locally computed *CEC* is allocated to compartments using the adjusting volume method described in Appendix 1 and then normalized using the correction factor above. The normalized energy consumptions of compartments are then summed to estimate the normalized total *CEC* of the refrigerator. This method can be summarized as follows:

1. The comparative energy consumption (*CEC*) levels corresponding to MEPS and the energy efficiency ratings for the identified typical model are calculated using the local test methodologies.
2. The local *CEC* value is then allocated proportionately to individual compartments according to the adjusting volume method for India as described in Appendix 1.
3. The difference of temperature specifications (both internal and external) for individual compartments between the local methodology and the Indian specifications is calculated.
4. The local compartment level *CEC* is normalized according to temperature differences. The normalized *CEC* values are summed to calculate the total *CEC* value.

All the calculations are conducted for a 250 l frost-free refrigerator with 50 l freezer volume is considered as a typical model. This model is the most common model available in the frost-free category in India. The choice of frost free category is influenced by two reasons: (a) the S&L program is mandatory for frost-free refrigerators in India unlike the direct-cool refrigerators and (b) although, the share of frost free is only 30% of the total refrigerator market, it is significantly increasing and is expected to surpass the direct-cool segment.

There is a lack of empirical evidence to identify the individual impact of the other factors (individual or in inter-relation). However, IEA mentions the aim of their approach is "… within a limited set of resources, provide policymakers with high level information to facilitate strategic decision making and/or to enable then to target further resources to investigate specific areas of interest". The objective also extends to this analysis.

3. Standards and Labeling (S&L) program in different countries

This section broadly describes the S&L programs in India, China, USA and EU.

3.1. India

S&L program for refrigerators is applicable for two most popular segments: direct-cool (DC) and frost-free (FF). DC refrigerators are single door refrigerators with natural convection for cooling which requires manual de-frosting. FF refrigerators are