India's experience in implementing strategic schemes to enhance appliance energy efficiency & futuristic integrated policy approaches to adopt most efficient technologies

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Abstract

Energy Efficiency (EE) in India has come to acquire a great deal of importance in the wake of the thrust that is being laid by the government to save its primary energy sources, combat climate change and provide 24×7 power to all. This paper reviews and analyses the strategic approaches of the government that led to ready access of efficient appliances to consumers and unlocked the potential for energy management at operational level.

On the one hand, existing national policies and energy saving models such as Appliance Standards & Labelling program (S&L) and Domestic Efficient Lighting Programme (DELP) help to trigger and transform an energy efficient – cost friendly market as well as achieve energy savings. On the other hand, some intergovernmental programmes & efforts like Space Cooling Efficiency Enhancement and Demand Response, India AC Challenge etc., aimed at meeting the increasing energy demand, help in the identification of future technologies and the potential barriers and challenges in adopting such most efficient technologies.

This paper will discuss and analyse the success and learning from these energy saving models and policy approaches, and lay out the possible options to overcome the barriers, propose integrated policy approaches to adopt and implement the most efficient technologies and the potential impact on energy savings and global climate change.

Introduction

India shares 17.5 % of the world population of which around 24 % is yet to have access to electricity.[1] Although the per capita annual electricity consumption stands low at 1,101 kWh[2], rapid urbanization and increasing income levels lead to greater demand for energy services, especially for home appliances. The last decade has witnessed a 50 % increase in per capita energy consumption, at an average rate of increase of 6 % every year[3]. The Indian consumer durables market (major electronics/appliances) has seen significant growth, reached US$9.7 billion in financial year 2015–16 and is expected to reach US$20.6 billion in financial year 2020–21[4]. This highlights the need for energy efficiency particularly in household appliance sector, which must accommodate rapid growth of consumer durables as well as meet peak energy demand.

The Government of India (GoI), enacted the Energy Conservation (EC) Act, 2001 and established the Bureau of Energy Efficiency (BEE) in 2002. The mission of BEE is to "assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy"[5]. GoI's Regulatory approach like the Appliance Standards & Labelling program (S&L) and EE programs for enhanced market transformation like the Super-Efficient Equipment

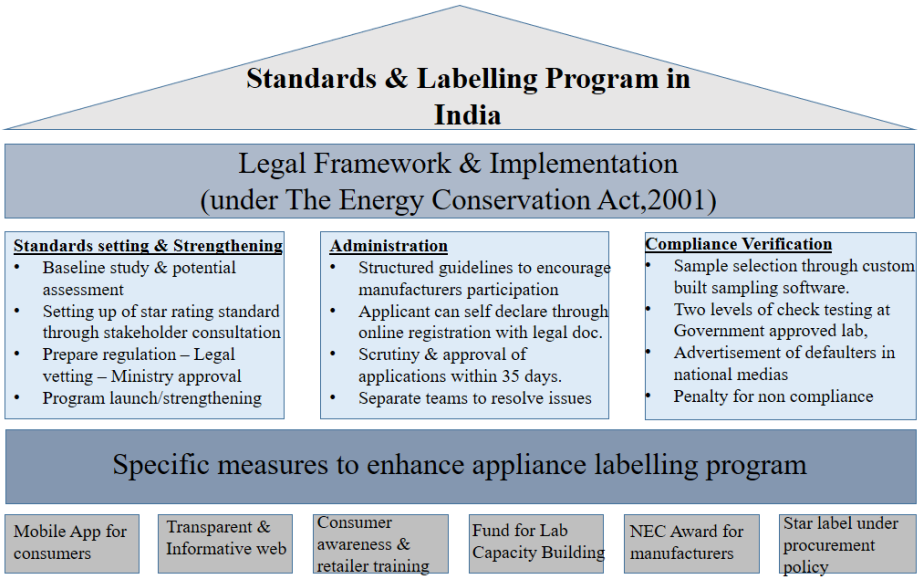
1. India's Intended Nationally Determined Contribution.

2. Draft National Electricity Plan (December 2016), Central Electricity Authority.

3. http://databank.worldbank.org/data/reports.aspx?source=2&series=EG.USE.ELEC.KH.PC&country=

4. http://www.ibef.org/download/Consumer-Durables-January-2016.pdf

5. Success Stories, National Energy Conservation Awards – 2015, Ministry of Power, GoI.



Journey so far:

2006: First voluntary labelling program for ACs and Refrigerators.

2007–2010: 12 products in voluntary program.

2010: Four appliances in mandatory regime.

2011–2016: 21 appliances in labelling program, of which 8 under mandatory regime.

Target:

Total 28 appliances under the scheme by 2017 (as per CEA).

Figure 1. Policy framework of Standards & Labelling Program in India (Source: See Reference [3]).

Programme (SEEP) and Domestic Efficient Lighting Programme (DELP) are aimed at transforming energy efficient – cost effective markets. The Planning Commission[6] under GoI has estimated that the total electricity consumption for the residential and commercial sector is 29 % and is increasing at a rate of 8 % annually[7]. It also states that the greenhouse gas (GHG) emissions due to household energy use are 173 MT CO_2 equivalent and are projected to reach about 261 MT CO_2 equivalent by 2020 assuming 8 % GDP growth. Therefore, the policy approaches outlined in this paper play a significant role in meeting the National Determined Contribution (NDC) under the Paris Agreement.

India is also engaged in the pursuit of super-efficient (SE) appliance technologies and their promotion with other governments to develop cost-effective appliance efficiency policies and accelerate market transformation. Deployment of super-efficient appliances and equipment is one of the key strategies to encourage low carbon inclusive growth.

This paper attempts to analyze the implementation strategy of the GoI's existing schemes like appliance Standards and Labelling program (S&L), Unnat Jyoti by Affordable LEDs for All (UJALA) scheme and the key learnings that lead to identifying integrated policy approaches to reduce the electricity demand by 2030.

Experience in implementing existing schemes

APPLIANCE STANDARDS & LABELLING PROGRAM (S&L)

One of the strategic options for driving down the emission intensity of the economy is to enhance the production and consumption of energy efficient appliances. The Standards & Labelling program is one such strategic policy approach to provide the consumer an informed choice about the energy efficient appliance and its energy and cost saving potential. Under the S&L scheme, with the permission of GoI, the manufacturer provides information related to the energy efficiency of a product with a star rating on a label affixed to the product. The star rating ranges from 1 to 5, where the highest star indicates the highest efficiency. The program has resulted in a cumulative savings of 29,771 MW during 2006 to 2014[8].The detailed framework of S&L and the process of implementation is depicted in Figure 1.

Key achievements apart from energy savings

- High penetration of labelled appliances among consumers as reflected by high level of consumer awareness for labeled products. A consumer survey revealed that 89 % of respondents realized reduction in electricity bills on purchasing labelled appliances. The consumer awareness of the star label increased to 63 % in 2014 from 33 % in 2010[9].
- Better understanding on energy conservation – program has built consumers' trust in labels and awareness of the need to save electricity.
- Manufacturers' view – the program has brought commitment to produce high quality products and is the biggest motivator for developing efficient products.

Major Barriers

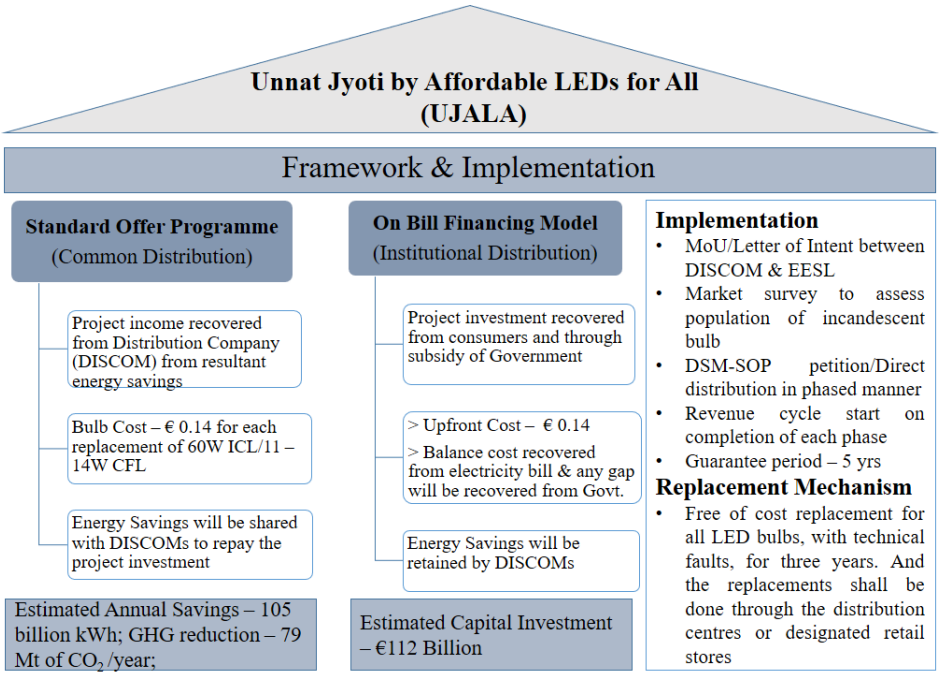
- Cost of appliances – additional investments required to produce energy efficient appliances and lower 'Return on Investment' (RoI) on high efficiency products from the market.

6. http://planningcommission.gov.in/aboutus/history/index.php?about=aboutbdy.htm

7. The Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth – April 2014, Planning Commission, GoI.

8. Draft National Electricity Plan (December 2016), Central Electricity Authority.

9. Impact Assessment of BEE's Standards & Labelling program in India, January 2015.



Illustrative example

location: Srikakulam & West Godavari – India
DISCOM: Eastern Power DISCOM
no. of bulbs: 2,586,000
project cost: €5.4 million
20 % equity & 80 % debt financing by EESL
repayment by DISCOM over and above project cost:
(i) Maintenance charge/year: 2.5 % of capital cost
(ii) Interest rate of 12.5 %
(iii) Govt. service tax
trade-off b/w pay out to EESL – €9.26 million
savings in power procurement cost for 5 years to DISCOM – €364 million

(Source: See Reference [1].)

Figure 2. Process of UJALA scheme implementation in India.

- Lack of incentives or replacement programs focused on increasing uptake of higher star rated appliances for higher star rated appliances.

Challenges

- Lack of willingness to pay additional cost for more efficient products limits their penetration in the market. There is a difference in cost of about 8–12 % (approx.) between a single star product and five-star product.
- Need for a robust market surveillance, compliance & verification mechanism.

UNNAT JYOTI BY AFFORDABLE LEDS FOR ALL (UJALA) SCHEME

Lighting alone consumes 18 % of the total electricity consumption in India[10]. Energy Efficiency Services Limited (EESL), a joint venture of several Public Sector Utilities of GoI has developed a demand aggregation scheme called *UJALA* [initially called Domestic Efficient Lighting Programme (DELP)]. The scheme aims to create a viable business model to promote large-scale replacement of an estimated 770 million incandescent lamps (ICLs) in India by 2019[11] i.e., 3 % of estimated lighting points in India for the same period. The scheme is implemented in association with distribution companies (DISCOMs) and has already resulted in significant market transformation with the distribution of 191 million LED bulbs since its implementation over the last three years. The detailed programme model & implementation methodology is depicted in Figure 2[12].

Key achievements apart from energy savings

- Reduction in retail cost – the scheme has brought down the market price of domestic LED bulbs from €11[13] per bulb to €0.92 in 2–3 years[14].
- Verification & replacement mechanism – any failure in samples during verification testing or faulty lamp after distribution can be replaced free of cost.
- Penetration of LED bulbs triggered the market for tubular LED technology as a replacement for conventional fluorescent tube lights.

Key lessons from the existing schemes

India's key policy initiative, 'Standards & Labelling', aimed at transforming the market towards energy efficiency, has delivered substantial energy savings since its implementation. The effectiveness of the S&L program is reflected by the fact that it has resulted in significant direct energy savings, as 77 %[15] of energy saving have been achieved from residential household appliances. However, one of the critical challenges to transform into a mature EE appliance market is insufficient demand-pull for energy efficient products and equipment. Figures 3 and 4 compare the actual market penetration per star rating of common household appliances in India during 2016 and the equivalent number of models under each star rating registered under the labelling program[16].

10. ELCOMA Vision document 2020.
11. http://pib.nic.in/newsite/mbErel.aspx?relid=126146
12. www.iitk.ac.in/.../EESL%20-%20Demand%20for%20Energy%20Efficiency%20-%20...
13. 1 INR = 0.014 Euro: http://www.xe.com/currencyconverter/.
14. 'India is the 2nd largest LED market in the world' – article published in Power Watch magazine, October 2016.
15. Draft National Electricity Plan (December 2016), Central Electricity Authority.
16. No. of AC models registered – www.beestarlabel.com/ /Home/Searchcompare.

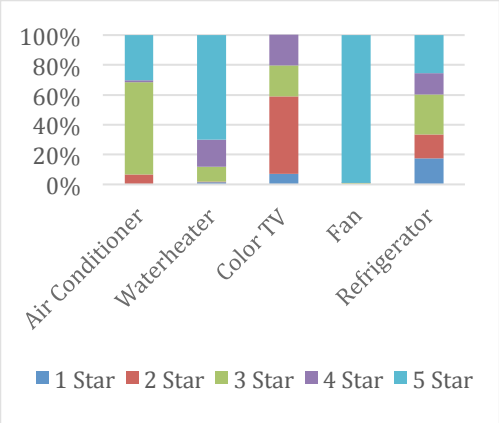


Figure 3. Market penetration of star-rated.

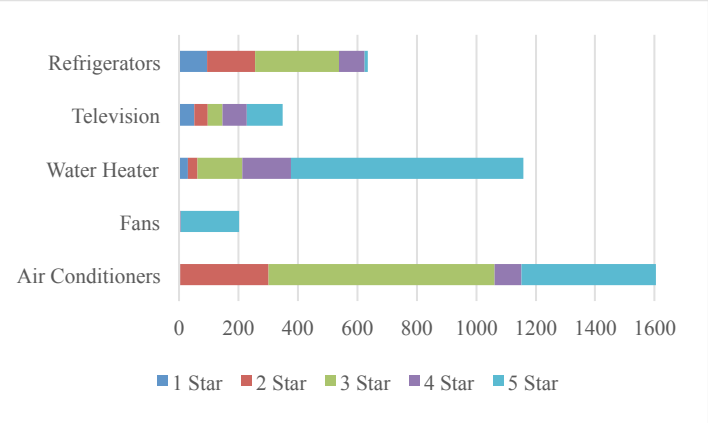


Figure 4. Star rated models available in the market products in 2016.

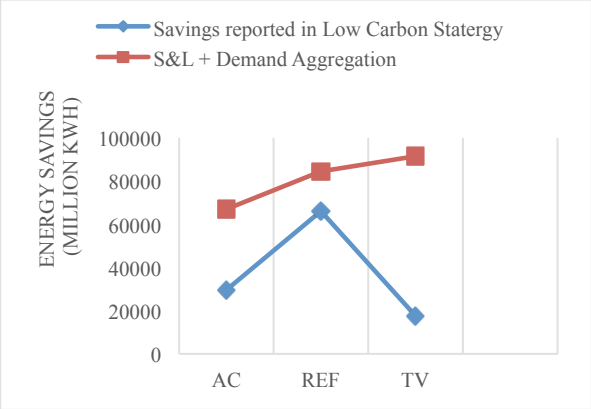


Figure 5. Savings Projections for 2030.

- *Total no. of models in operation by 2030 – taken as projected by Planning Commission*
- *Assumptions & Potential savings (baseline with respect to year of launch and Star 1 of respective product)*
  - *Air Conditioner – 10 % of current 4 Star penetration in 2030 results in 56 % more savings*
  - *Refrigerator – 10 % of current 5 Star penetration in 2030 results in 22 % more savings*
  - *Television – 10 % of current 5 Star penetration in 2030 in 81 % more savings*

The figures show that 5-star rated models of water heaters and fans have already witnessed significant market transformation while those of colour televisions (CTVs), air conditioners (ACs) and refrigerators are still lagging. The impact assessment study for the S&L program[17] revealed that the higher cost of higher efficiency appliances is one of the key barriers. Most consumers are willing to pay only a small additional cost for efficiency improvements. This highlights the need for suitable policy intervention to scale up the penetration of higher EE appliances as well as to incentivize the consumer to purchase appliances that are more efficient.

On the other hand, implementation of the *UJALA* scheme has made a huge impact in penetration of LED bulbs into the domestic market, up by 15 % (as of Oct 2016) from 0.1 % in 2013[18]. Therefore, in order to realize more savings and overcome the barriers/bridge the gaps, the S&L EE appliance needs to be integrated into similar policy approaches.

Proposed Integrated Policy Approaches to achieve higher impact and savings

INCORPORATE STAR RATING IN PROCUREMENT POLICY/DEMAND AGGREGATION SCHEME

Integrating star rating requirement into the bulk procurement programmes like *UJALA* will benefit both the programs in following ways:

a. Bridge the price gap between higher & lower star-rated appliances – one of the successful outcomes of the *UJALA* scheme is demand aggregation resulting in price reduction of the product. Incorporating the star rating in the procurement requirements will help in increasing the penetration of higher star EE appliances and lead the market towards affordable pricing.

b. Enhanced credibility due to compliance check – although the *UJALA* scheme has quality checks, there is no information on compliance of desired output (i.e., lumens or lumen/watt). However, the star rated products undergo random check-testing process after issuance of star labels & any product found to be non-compliant should take necessary action to come into compliance. Integrating star label will automatically check for star mark/efficiency compliance of products under the bulk procurement, which will ensure the credentials of both the programs. A separate compliance mechanism would not be required for ensuring the performance of product under *UJALA* scheme.

c. Help build consumer awareness and trust for Government program and policies.

17. Impact Assessment of BEE's Standards & Labelling program in India, January 2015.

18. 'India is the 2nd largest LED market in the world' – article published in Power Watch magazine, October 2016.

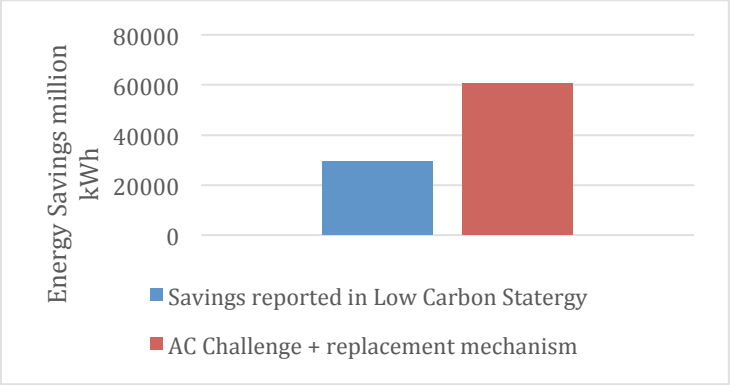


Figure 6. Impact of Savings Projections for 2030.

- *Total no. of ACs in operation by 2030 – taken as projected by Planning Commission*
- *Assumptions & Potential savings – 30 % of AC's sold in 2011 replaced with SE AC + BAU penetration through S&L approach – 52 % more savings*

An example to show how higher energy savings can be achieved than currently planned projections: Figure 5 depicts the impact of a combined approach of demand aggregation and S&L in comparison with the business as usual (BAU) S&L approach projected by planning commission.

COMBINATION OF APPROACHES IN LINE WITH INDIA AC CHALLENGE PROGRAM

India's estimated air conditioning demand is around 150 GW by 2030 at a growth rate of 15 %/year[19]. Minimum Energy Performance Standards (MEPS) for room ACs are under the mandatory S&L program in 2010 and have undergone revision three times resulting in an overall efficiency improvement of 25 % by 2016. The current energy efficiency thresholds for fixed speed 5-star AC is 3.5[20] EER (Energy Efficiency Ratio) and is 4.5[21] ISEER (Indian Seasonal Energy Efficiency Ratio) for the variable speed 5-star AC. A collaborative Indo-US initiative called the 'AC Challenge program' is under development. The initiative aims to catalyze market transformation towards super-energy efficient RAC of 5.5 ISEER or above. The incremental cost analysis study by Bureau of Energy Efficiency (BEE) – Collaborative Labelling and Appliance Standards Program (CLASP) – Department of Energy (DoE)[22] looked at the potential options to improve efficiency at the component level and the associated costs to establish a least cost curve for overall appliance efficiency improvements. Based on this understanding, the paper suggests and discusses two broad approaches for implementation.

Incentive based program approach

A scheme to replace old/dated star rated appliances with the identified super-efficient models. The calculation of the incentive to the consumer is illustrated below:

Illustration for AC incentive replacement mechanism

Efficiency of AC identified under the AC challenge program – 5.5 ISEER

Estimated Retail cost of Super-efficient AC with 5.5 ISEER[23] – €899

Maximum life of AC – 10 years[24]

Operating hours/annum – 1,600 hours (as per BEE)

Avg. Energy Consumption of AC with 2.3 EER – 3,667 kWh/year & 5.5 ISEER is 1,533 kWh/year

Therefore, an AC with 2.3 EER in 2011 when replaced with an AC of ISEER 5.5 will result in a cost savings of approx. €147/year. This amount works out to be 16 % of the retail cost of SE AC. Thus, an incentive of the same value provided to the consumer can reduce the demand by 2,133 kWh/year for every replacement of an old AC.

The impact on energy savings for the approach is shown in Figure 6.

Seasonal tariff rebate scheme for Air Conditioners and Refrigerators

According to National Building Code, India has five climatic zones[25] *viz* warm and humid, hot and dry, temperate, composite, cold. The Indian Weather Data Handbook 2014 provides temperature and related parameters for 57 major cities within these five climatic zones. Assuming the use of ACs and refrigerators is for longer duration in specific climates; this paper recommends an electricity tariff rebate for purchase and use of Super-Efficient ACs and Refrigerators. The rebate can depend on the energy savings resulting from the use of superefficient appliances. This will contribute to reduction of peak demand as well as market transformation of high efficient products.

The seasonal tariff rebate scheme can be implemented in partnership with the DISCOMs as:

1. direct deductions in the consumer electricity bill

19. https://beeindia.gov.in/sites/default/files/ctools/SEAD%20webpost_0.pdf

20. The Gazette of India: Extraordinary [Part II, Sec.3 (ii)], S.O.3543(E) dated 29th December, 2015.

21. Schedule 19, Variable Capacity Air Conditioners – https://www.beestarlabel.com/Content/Files/Inverter%20AC%20schedule%20final.pdf.

22. Cost benefit for improving the efficiency of Room Air Conditioners (Inverter & Fixed Speed) in India, LBNL-1005787.

23. Figure 2, Cost benefit for improving the efficiency of Room Air Conditioners (Inverter & Fixed Speed) in India, LBNL-1005787.

24. Planning Commission, Government of India "Low Carbon Strategies for Inclusive Growth: Interim Report", May 2011.

25. Section 3.2, Part 8, National Building Code of India 2005.

Table 1. Illustration for seasonal tariff rebate mechanism.

Climatic Zones*	Average Hours (out of 8,760 hours in a year) with temperature >35 °C	Avg. Energy consumption of current 2 Star AC (kWh)	Avg. Energy consumption of SE AC (kWh)	Energy Savings (kWh) /AC/ year	Rebate amount for 2 years for every SE AC (in €)	Actual cost of AC to Consumer (in €)
Warm & Humid	341	2.0	0.958	339	47	852
Hot & Dry	940	2.0	0.958	934	131	768
Composite	649	2.0	0.958	645	90	809

** Excludes temperate & cold climatic zones, as there are less annual hours in the temperature range of 35 °C or above.*

2. year-end claim by producing electricity bill at DISCOM office, or
3. discount of equivalent amount while purchasing any appliance having efficiency of Star 5 or above.

Illustration for seasonal tariff rebate mechanism:

Efficiency of AC identified through AC challenge approach – 5.5 ISEER

Estimated Retail cost of SE AC with 5.5 ISEER[26] – €899

Average Tariff Cost assumed – €0.07

Tariff rebate at the cost of average annual peak hours can be provided to the consumers for a purchase of SE ACs. The impact of energy savings & cost as per the proposed approach is as follows in Table 1.

This would also result in annual peak demand reduction of 3,836 kWh/unit of SE AC to the DISCOM. A similar approach may also be implemented for the market transformation of SE refrigerators.

Conclusion

India aims to achieve a high economic growth rate in coming decades, and ensuring energy security to sustain the growth rate is of utmost importance. GoI set the pace for efficient use of energy in all sectors through appropriate policies and realized the energy savings through ambitious schemes and programs. Appliance energy efficiency has been a flagship program of BEE, GoI. The cumulative savings from S&L (from 2006–2014) and *UJALA* (till February) alone had resulted in 35,227 MW of avoided capacity generation. Both the programs target the end user for utilization of efficient appliances & market penetration. Recognising the growing demand for energy for economic growth and the importance of energy efficiency, this paper highlights the need and the importance of accelerating the pace for the deployment of high-energy efficient technologies and transforming the markets. Although, setting up MEPS is a key regulatory tool for enhancing the EE market, a periodic review and strengthening of the standards is equally important to remove the least efficient products from the market. The analysis in the paper shows that the potential impact on energy savings can be exponentially higher through integrated policy approaches than projected by the current policies. These approaches not only will result in increased energy savings, but also transform the appliance market towards super-efficiency.

India's projected electricity demand is 2,499 TWh by 2030[27]. This paper establishes the potential to reduce the electricity demand in 2030 by at least 10 % of projected overall demand through integrated policy approaches. This would also result in an emission reduction of 210 Mt CO_2.

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26. Figure 2, Cost benefit for improving the efficiency of Room Air Conditioners (Inverter & Fixed Speed) in India, LBNL-1005787.

27. India's Intended Nationally Determined Contribution.