Strategic Actions for Rapid Implementation of Energy Efficiency

A Discussion Paper

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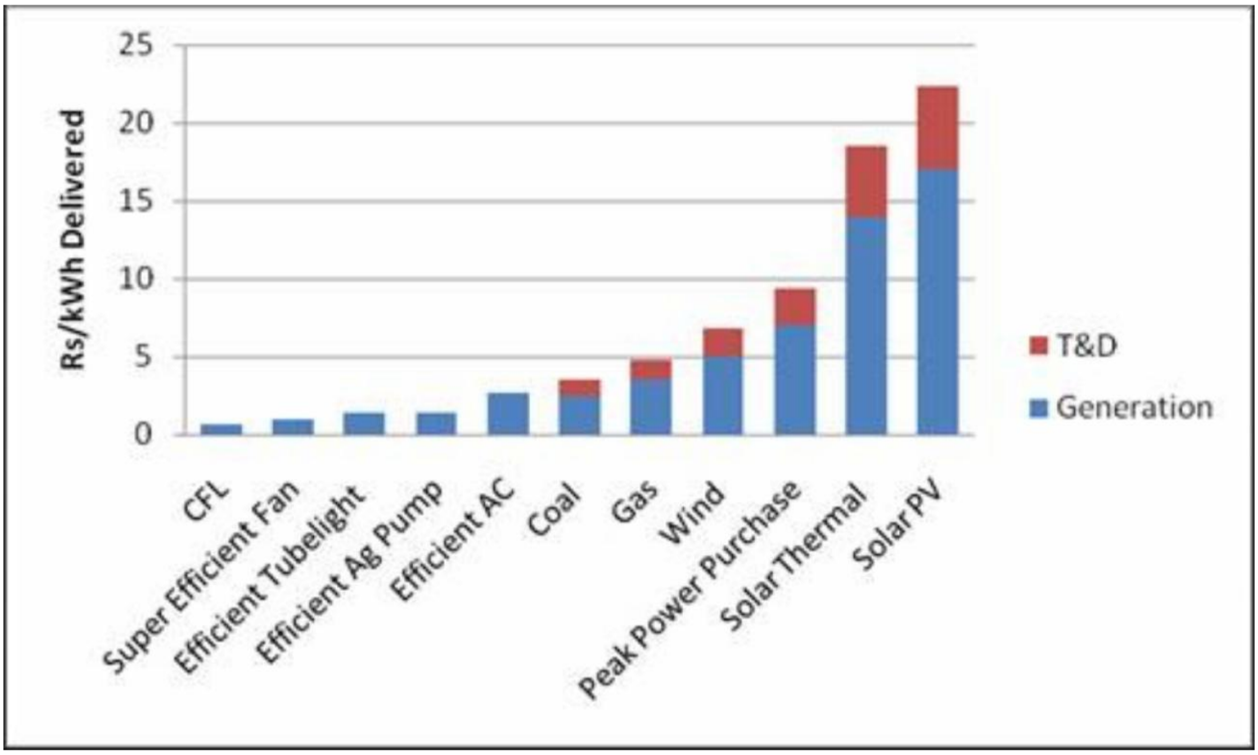
Introduction

With growing concerns about India's energy security and climate change, the importance of improving the energy efficiency (EE) of the economy is being realized by Indian policy makers, and significant efforts are being made to enhance EE in the country. Yet progress in EE implementation has been slow compared to its potential and benefits. Internationally as well as domestically, EE policies have been undergoing major changes in order to facilitate rapid implementation of EE. This paper, with a focus on the electricity sector, is an attempt to enhance the discourse on the required transformation of EE policies in India.

In spite of the importance of EE, it gets far less attention at the policy level and in terms of financing, in comparison with other green-energy options. Further, while a variety of approaches and schemes are being tried in India, most of them have originated in developed countries and do not address the challenges of the Indian policy and implementation environment. The Indian context poses different and more challenging difficulties because of limitations of human and financial resources and institutional capacity. Furthermore, there is no document that lays out the relative importance and priority of either the various approaches and schemes or the sub-sectors in which they are being tried. Under these circumstances, it is important that we re-organize our efforts in order to make the most of our limited resources. Three principles should guide these efforts: (1) Our efforts must be directed at the areas where we will get the biggest reductions in energy use ("maximum bang for the buck"); (2) Our EE policies and plans must be designed for a radically higher level of implementation; and (3) Our EE schemes should be designed creatively to address the challenges of the Indian environment.

In the next section, we remind our readers about why it is urgent to rapidly improve the EE of the Indian economy. Then in section three, we identify priority areas based on energy saving potential. In section four, we describe the characteristics of the policy and implementation environment for energy efficiency in India which can pose a significant challenge and which must be addressed while developing policies for EE in India. In section five, we take the example of appliance efficiency and describe an EE program of BEE that takes into account the challenges of the Indian environment. We discuss appliance efficiency in more detail because we have done more work on that area. For other important sectors for which India-specific schemes need to be designed, we list some factors that need to be considered in the design of EE programs and schemes in section six to spur the thinking of others who have more experience and knowledge in those areas. We end with our conclusions and suggestions for moving forward on rapidly accelerating energy efficiency in the India. Our hope is that this paper will provide a spring-board for further discussion and analysis of strategies for rapidly enhancing the energy efficiency of the Indian economy.

Figure 1: Comparison of cost of energy efficiency and renewable energy



Source: Lawrence Berkeley National Laboratory and Regulatory Assistance Project, *First Steps on the Road to India's Low Carbon Future*, April 2010.

Note: The costs in the figure are indicative only.

Urgent need for rapid implementation of EE

Despite the acknowledged importance of EE, and relatively lower cost compared to another green-option, renewable energy (RE), the progress of EE has been sluggish. Figure 1 compares the cost of saved energy from some of the EE options with the cost of energy for RE options. Most EE options have a much lower cost than the RE options, although some of the EE options (not seen in simplified figure above) are more expensive than low-cost generation options such as coal. The barriers for achieving this low cost potential of EE are more in the realm of institutional and policy issues. For example, EE receives limited funds and policy attention. The national agency, Bureau of Energy Efficiency (BEE) has staff strength of only 50, with an annual budget of Rs 350 Crore,[1] completely disproportional to the task at hand.

This treatment of EE is also related with the popular perception about it. Most people see EE as desirable, something that will be "nice to do." However, the absolute urgency for

[1] Until the last year the BEE budget was only about a third of this amount.

improving the EE of the economy actually requires that it is seen as an imperative. Let us see some of the reasons for this urgency.

- About 70% of the infrastructure in 2030, such as buildings, will be added in next two decades – between 2010 and 2030. If this is built inefficiently, we will be locking-in this inefficiency. The issues for appliances and equipment are similar, however, with faster growth and shorter life than infrastructure, the time span for action and impact is shorter. With scarce and costly energy in 2030, such inefficiency would be a major handicap for the country.
- The projections for energy demand in 2030 imply a four-fold increase in the requirements. For example, meeting the electricity projections would require the addition of 40,000 MW/year in 2030. This is much larger than the current capacity addition rate of about 12,000 MW/year. There is a surreal quality to this type of planning or forecasting. It seems to ignore the difficulty of dramatically increasing energy supply. Siting of power plants is already very difficult and likely to only get worse. As the better sites are taken up, concerns about environmental impacts, displacement, and land and water availability are going to become greater.
- With current projections of energy use, India is likely to hit resource constraints. Even for coal, our most abundant energy resource, import dependence is likely to increase to 30-50%. Growing Indian and Chinese coal imports are not only likely to increase global coal prices but may also lead to non-availability of additional coal. Indonesia's recent ban on coal exports may be a pre-cursor of such a scenario.
- Under current projections of energy demand, India's GHG emissions would dramatically increase. Although Indian GHG emissions are much below the global average per capita emissions, an increase will exacerbate concerns about global climate change.[2]
- The achievable EE potential in the coming decade is larger than the likely combined capacity addition through hydro, nuclear and gas based power plants. Seen against this back-drop, it is alarming that due to insufficient policy response, we may miss out on such a large and low cost opportunity to meet our energy needs and may get trapped with energy- inefficient infrastructure.

In fact, it can be argued that unless EE is aggressively pursued, it would simply be impossible to meet the energy demand of the growing economy. Hence, EE should be seen as indispensable as power plants in avoiding shortages, facilitating growth and maintaining competitiveness.<u>EE deserves the same importance as that of addition of electricity generation capacity</u>.

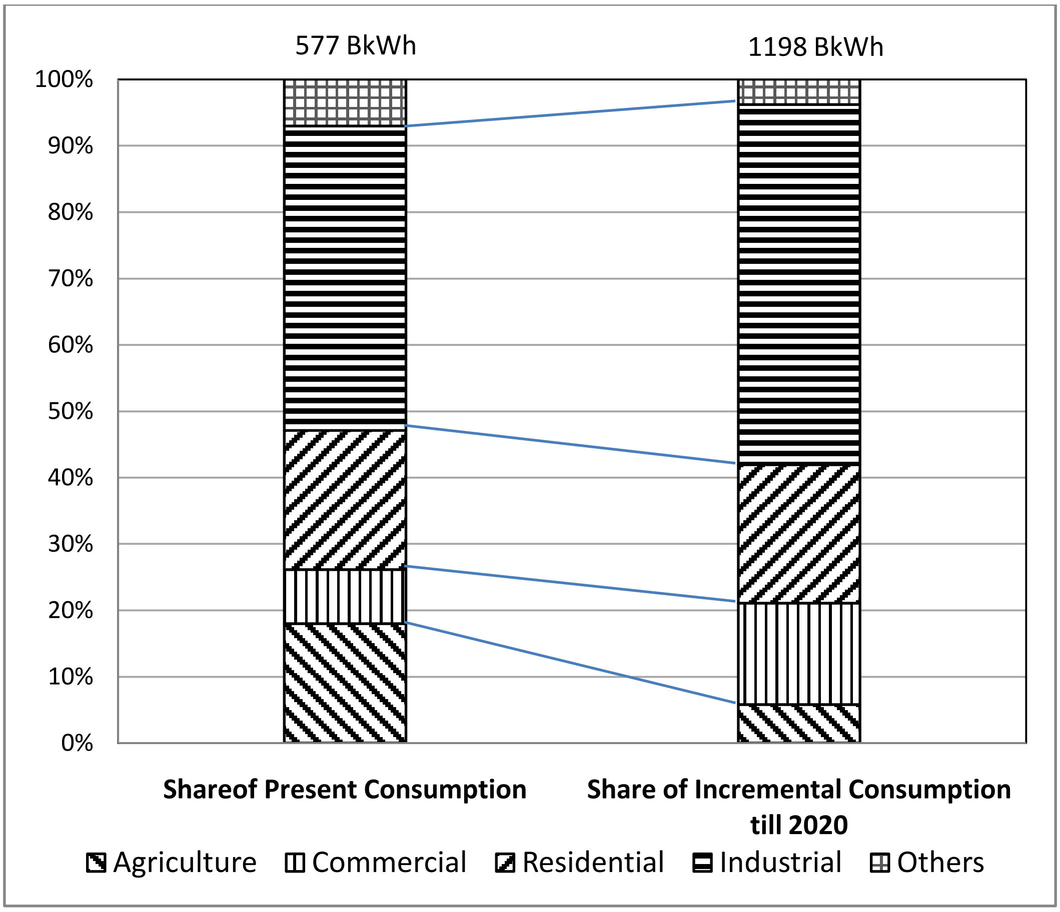
[2] Although, per-capita GHG emissions of India in 2030 even under these projectionswould be low, Indian emissions will be a large part of the remaining global carbon budget due to the historical over-occupation of carbon space by industrialized countries.

Priority analysis

As a first step for identifying the high priority areas, it is essential to estimate the saving potential by consumer categories. After doing so we also divide it between present use and new additions to facilitate the discussion on appropriate strategies.

Figure 2 shows the category-wise contribution to (a) current consumption and (b) to the incremental consumption between now and 2020.The estimate of incremental consumption is based on category-wise growth rates of consumption which in turn, are based on the observed rates in the recent past, with some corrections.[3]We assumed that agricultural consumption would grow at about 4% until 2020, commercial 13%, residential 9%, and industrial 10%. For the residential category, we assume that consumption growth would be slightly higher than the five-year average of 7.7%, due to rapid increase in incomes and reductions in power shortages.

Figure 2: Category-wise share of current and incremental electricity consumption until 2020



[3] While we use the best available information to make projections, we have had to make assumptions. Our results in this paper are intended to be indicative of the saving potential and not precise calculations of it.

As can be seen from Figure 2, dominance of industrial consumption may increase in the next decade. The share of residential consumption remains roughly same, at 20%. However, agriculture and commercial categories show substantial change in their share of consumption. Agriculture is a significant contributor to current consumption (18%) but it forms a very small share of the incremental consumption. In contrast, commercial consumers contribute only 8% of the consumption, but because of a high growth rate, their contribution is likely to nearly double and form 15% of the incremental consumption.

As the next step, we look at the saving potential associated with present and incremental consumption. This first-cut analysis uses the aggregate estimates of saving potential for each consumer category based on previous studies and conversations with other researchers. We assume a saving potential of 15% for the industrial sector and 30% for all other sectors. These estimates are consistent with the general view that Indian industry is fairly efficient and there is much greater efficiency potential in the other sectors. Continuing with the broad-brush approach, we assume that these estimates apply to both reductions in present consumption (through retrofit measures) and incremental consumption through new installations or appliances.[4]

We wish to note two caveats to this broad-brush analysis. First, retrofits or pre-mature retirements are less cost-effective[5] and more tedious to implement than new purchases, except for lighting which we discuss in the next paragraph. In addition, the majority of existing residential and commercial appliances as well as equipment like pumps are expected to wear out over the next decade and be replaced by new appliances and equipment. Hence, our calculation over-estimates the saving potential of retrofits to a certain extent. Second, in contrast, in some cases the cost-effective saving potential is likely to be higher than we have estimated. For example, with proper choice of building design, orientation, materials, and appliances, cost-effective savings for new commercial buildings could be as high as 40%. Similarly, super-efficient appliances (SEAs) consume 40-50% less energy than average appliances sold today, and their use would increase the saving potential. Despite such issues, the estimates are useful to arrive at key conclusions, as discussed later.

Lighting forms a special case and many of our comments about retrofits do not apply. Lighting retrofits are often very cost-effective. In addition, lighting retrofits are easy to implement particularly where the fixture does not have to be changed. For example, replacement of an incandescent bulb by a CFL is easy; however switching from T12 tube-

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[4] The saving estimates need to be refined based on detailed bottom-up studies for each consumer category and end-use.

[5] For example, suppose the cost of a 5-Star fan is about Rs 1500 while the cost of an unlabeled fan is Rs. 1300. Also assume the power consumption is 50W and 75W for the two fans respectively. If a consumer decides to buy a new fan and chooses the 5-Star model, then his additional cost is only Rs.200 (1500-1300) giving a cost of conserved energy of about Rs. 0.90 per kWh. On the other hand, if the consumer decides to replace an existing fan with a new 5-Star fan, then his additional cost is Rs. 1500 and the cost of conserved energy is Rs. 6.60 per kWh, making it much less economically attractive.

lights to T-5s with a change in the ballast may be more involved. Furthermore, where no change in fixture is required, due to the short life of bulbs and other lights, there is not much of a difference between a retrofit and a new purchase. Therefore, lighting needs to be treated differently and our comments on appliances may not necessarily apply to this end-use.

Figure 3 shows the saving potential for each consumer category, further divided into retrofits and new additions. Table 1 shows the same information considering saving potential in existing commercial buildings (commercial retrofits) to be equal to 1 unit.

Some conclusions regarding higher priority areas stand out from this analysis:

- The saving potential from energy efficiency in new additions in industrial, commercial, and residential consumer categories is far larger than other segments.
- It is important to focus on new additions: First, the saving potential in new additions is substantially greater than from retrofits in these categories. Second, as discussed earlier in this section, retrofits are more expensive and tedious to implement. The prominence of this conclusion for the commercial sector is so striking, that we should seriously consider focusing the limited human resources we have on new construction only.
- In the case of agriculture, retrofits are more important than new additions. But even here, tackling the existing pump installations by influencing the new pumps sales should be considered.
- The category labeled ‘Others’ has limited potential: Railways is a big part of the ‘Others’ category. The remaining constituents of this category, such as street-lighting and municipal water pumping may have benefits such as visibility, but have limited saving potential.

In summary, given the higher saving potential of new additions in the residential, commercial and industrial categories, we need to ensure that new additions are energy efficient.

Figure 3: Category-wise saving potential of retrofits and new additions until 2020

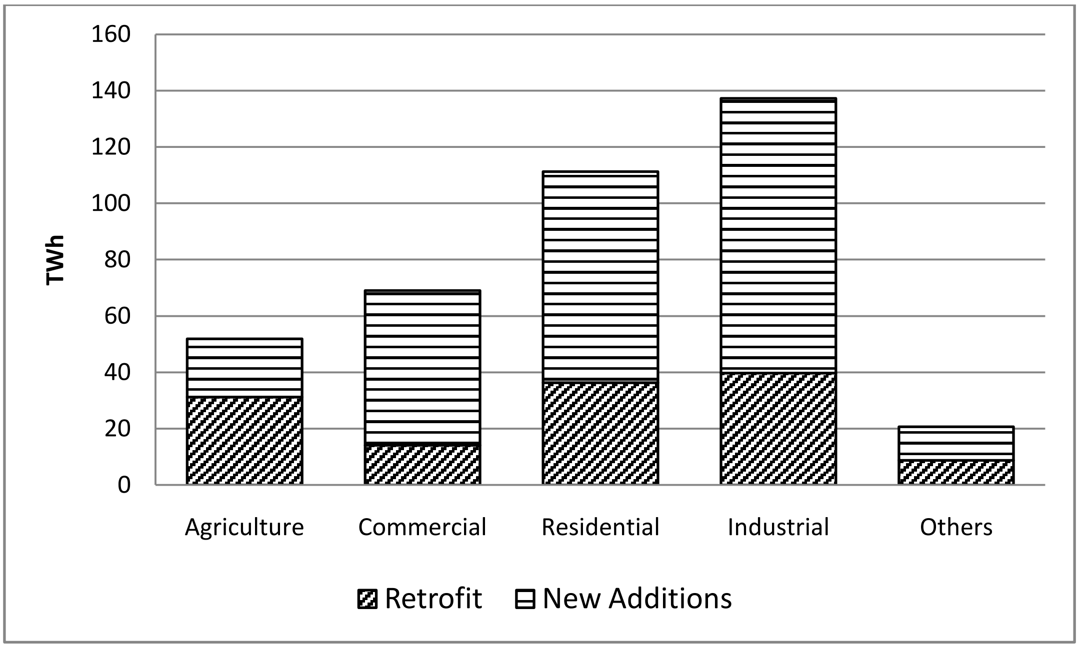

Table 1: Relative scale of saving potential for different consumer categories
(Relative to saving potential for retrofits in commercial category)

Category	Retrofits	New Additions
Agriculture	2.2	1.5
Commercial	**1.0**	3.8
Residential	2.6	5.3
Industrial	2.8	6.9
Others	0.6	0.8

Characteristics of the Indian energy efficiency space

After identifying the focus areas, the next task should be to design schemes for rapid adoption of EE solutions in these areas. The design of schemes requires consideration of the special characteristics of the Indian energy efficiency environment, which may be quite different from those in industrialized countries. Some of these characteristics are:

- Weak institutions at the center and the states with associated shortage of human resources and expertise at most levels of the energy efficiency space, from policy formulation to implementation.

  - The capacity to carry out effective evaluation and monitoring of projects is also limited. This is partly due to the weakness of institutions and partly due to lack of expertise for carrying out such tasks.
  - A lack of effective monitoring exacerbates the ever present possibility of corruption. As EE programs become larger, it will be very important to control corruption, otherwise, it could lead to higher costs for EE programs, poor quality of products, inaccurate estimates of savings and may even derail the programs.
- Most electric utilities are preoccupied with urgent tasks like T&D loss reduction, mitigating financial losses, power shortages and load shedding, which are part of the utility's core mandate and are seen as more urgent then EE. Utilities are unwilling to allocate capable human resources for EE and are also risk-averse in this new area. Hence, programs requiring a large role from utilities are in general unlikely to succeed, although there could be some exceptions in those rare cases where the utility is proactive on EE and has the expertise to carry EE programs forward. Regulatory institutions, are often weak because of shortage of staff and/or limitation of capacity. Consequently approaches that require strong regulatory intervention or oversight are difficult to implement.
- Considerable economic activity takes place through small and medium enterprises (SMEs) in the informal sector, which are partly outside the legal and taxation ambit, and therefore, difficult to regulate. Consequently, approaches that rely primarily on strict standards and penalties for non-adherence (stick approach) may not work for SMEs, and instead more incentive-compatible approaches (carrot approach) may be more effective.[6]
- One of the positive features of the Indian context is that, because of the high cost of energy relative to incomes, consumers and manufacturers do respond to economic incentives.
- Another positive feature is the existence of national agencies like BEE and Energy Efficiency Services Limited (EESL) that can provide support in policy formulation (BEE) and implementation (EESL) for schemes that facilitate rapid scaling-up of EE.

These features of the Indian context indicate that the chances of success are likely to be much higher if EE schemes for India have the following characteristics: (1) The scheme design is centralized or standardized to make the most of limited expert resources; (2) Reliance on proactive actions by multiple institutions is avoided to minimize the effect of lack of capacity in various institutions; and (3) Greater EE is encouraged through rewards, such as tariff reduction, rather than only through strict standards and penalties for non-adherence.

[6] Even for segments of the industrial sector that consist of mainly big players, onerous regulations are likely to incentivize shifting of production and sales into unorganized and unregulated channels.

Developing an approach for residential and commercial appliances

With the high economic growth in India, there has been a boom in the sales of electrical appliances in the residential and commercial sectors putting a tremendous burden on the already resource-constrained power sector. Furthermore, because of this high growth rate in sales, most of the appliances in 2020 will have been added just since 2010. Therefore, in order to ensure that we are not stuck with a stock of inefficient appliances, there is a need to rapidly improve the EE of new appliances being sold in the Indian market.

BEE has been implementing a standards and labeling (S&L) program for different electrical appliances since 2006. The program is mandatory for some appliances and voluntary for others. Every model is rated for its energy efficiency and the rating is given in the form of stars, a model earning a 5-star rating being the most energy-efficient. Appliances for which the program is mandatory must earn at least 1 star before they can be marketed; thus the 1 star performance becomes the *de facto* minimum energy performance standard (MEPS). While for some appliances, there is an encouraging shift to more efficient models due to the S&L program, for many others new buyers still buy inefficient but less expensive models.

In parallel with BEE's efforts to raise appliance EE levels, there have been initiatives by state and central electricity regulatory commissions which regulate electric utilities in their respective jurisdictions. In these states, this has led to some utility-administered programs, mostly for subsidized sale of CFLs, T-5 tube-lights, ACs and fans, where the utility recovers the cost of the programs through the annual revenue requirements which form the basis of consumer tariffs. However, even these utility programs in India are small and should be classified as pilot programs. Further, some of the early programs of CFLs have had high failure rate of lamps[7] and many programs lack proper monitoring and evaluation.

In short, the development of utility-administered DSM programs and the shift to efficient appliances in India has been sluggish. Some of the reasons for the slow development are related to the characteristics of the Indian EE environment discussed earlier in Section 4: (1) lack of expertise in DSM in utilities and regulatory commissions; (2) diversion of utility attention by other issues such as electricity shortages and high distribution losses; (3) reluctance of utilities to propose and design programs on their own.

Furthermore, there is still a very large difference in the energy consumption between the best available technology world-wide and current efficient (5 Star) level appliances in India. Because most Indian consumers are very conscious of the initial cost of an appliance, highly efficient but more expensive models are generally not sold in the Indian market. Table 2 shows the gap in EE between the 5-Star level and the world's best commercially available technology for the four key appliances that are responsible for about half the consumption in Indian households.

[7] Prayas Energy Group, *Review of Nashik Pilot CFL Program of Maharashtra State Electricity Distribution Co Ltd*, Pune, India, December 2007

Prayas has estimated the technical saving potential in 2020 from a program promoting super-efficient appliances (SEA) relative to a moderate S&L program.[8] The saving potential is calculated based on the reduction in electricity consumption due to new appliance sales from 2010. The sales include both first time sales and replacement of old stock. Sales data and growth percentages are determined from various market research reports (Euromonitor, 2010 and CRISIL, 2010). The study considered a constant (conservative) appliance-specific sales cumulative average growth rate (CAGR) over the period 2010-2020. The results show that there could be annual savings of about 60 TWh in 2020 due to the shift to SEAs over the moderate standards and labeling scenario. This amounts to a reduction in 2020 of about 15% of residential electricity consumption just from four appliances.

Table 2: Comparison of performance of 5-Star appliances and SEAs

Appliance	Unit	5 Star level in India (2010)	SEA level (2010)	Decrase in Unit Energy Consumption (%)	Basis for SEA level
Room Air Conditioners	EER	3.1	4.9	36	The most efficient grade 1 AC (1.5T) in China. (Source: Top 10 China, 2010.)
Frost Free Refrigerators	kWh/yr	411	128	69	The most efficient grade 1 215 litre FF refrigerator consumption in China. (Source: Top 10 China, 2010)
Televisions	kWh/yr	62	36	42	A 32” LCD model in US with LED backlighiting and auto brightness control consumes 36 Watts. (Source: Top 10 US, 2010)
Ceiling Fans	W	51	35	32	Use of brushless DC (BLDC) motor

Source: *Potential Savings from Selected Super-Efficient Electric Appliances in India*, Prayas Energy Group, Pune, March 2011.

A new approach is required to quickly narrow the gap between average efficiency of appliances sold in the Indian market and the most efficient commercially available appliances world-wide, and capture as much as possible of the energy saving potential that exists. At the same time, any alternate approach must address the challenges of limited expertise, human and financial resources available in utilities and regulatory commissions. National Programs (NPs) with a focus on market transformation through incentives to manufacturers to develop and sell SEAs provides a promising alternative. Next we describe

[8] *Potential Savings from Selected Super-Efficient Electric Appliances in India*, Prayas Energy Group, Pune, March 2011.

NPs in some more detail and describe how their features could meet the challenges of the Indian energy efficiency space and also capture much of the saving potential available.[9]

Unlike a utility DSM program where the program design and implementation is done by each utility, the design of an NP and much of the implementation would be done by national agencies (BEE and EESL), considerably reducing the burden on utilities and state regulators and bypassing many of the difficulties with utility-administered programs. If each State Electricity Regulatory Commission (SERC) decides to independently initiate DSM in its respective state, the regulatory burden on each for developing regulations, issuing orders, assessing DSM program proposals, approving and then reviewing M&E reports would be substantial and repetitive. The central agencies that design the DSM program, implement it, and arrange for M&E could substantially reduce the burden on utilities and regulators.

An additional feature of the proposed NPs for India would be incentives to manufacturers' for selling SEAs[10]. The required incentive for such an NP is expected to be considerably lower compared to an equivalent utility-administered program for two reasons. First, giving upstream incentives avoids wholesale and retail mark-ups and taxes – reducing the required incentive to about the half. Second, a single entity (for example BEE or EESL) acting on behalf of all utilities in India would have much greater bargaining power while negotiating with manufacturers because of the larger market size at stake as compared with each utility attempting to negotiate with manufacturers separately. In addition, manufacturers can take advantage of the greater economies-of-scale from selling appliances to a national market as compared to selling in each utility service territory and meeting the individual DSM program specifications. Both – greater bargaining power and larger economies-of-scale – are likely to lead to lower program costs for a national-scale program as compared with several utility-scale programs.

Upstream incentives with NPs thus serve two functions: (1) they provide incentives to manufacturers to develop and sell SEAs that they would not otherwise do, thus bringing about a market transformation to much more efficient products; and (2) they lower the price that would be seen by customers thus serving the same purpose as customer rebates but at a lower cost to the subsidizing agency.

As we have seen NPs will: (1) considerably reduce the burden on state regulators and utilities, bypassing many of the difficulties with utility-administered programs; and (2) lower the subsidy required to promote SEAs. NPs have other benefits, such as:

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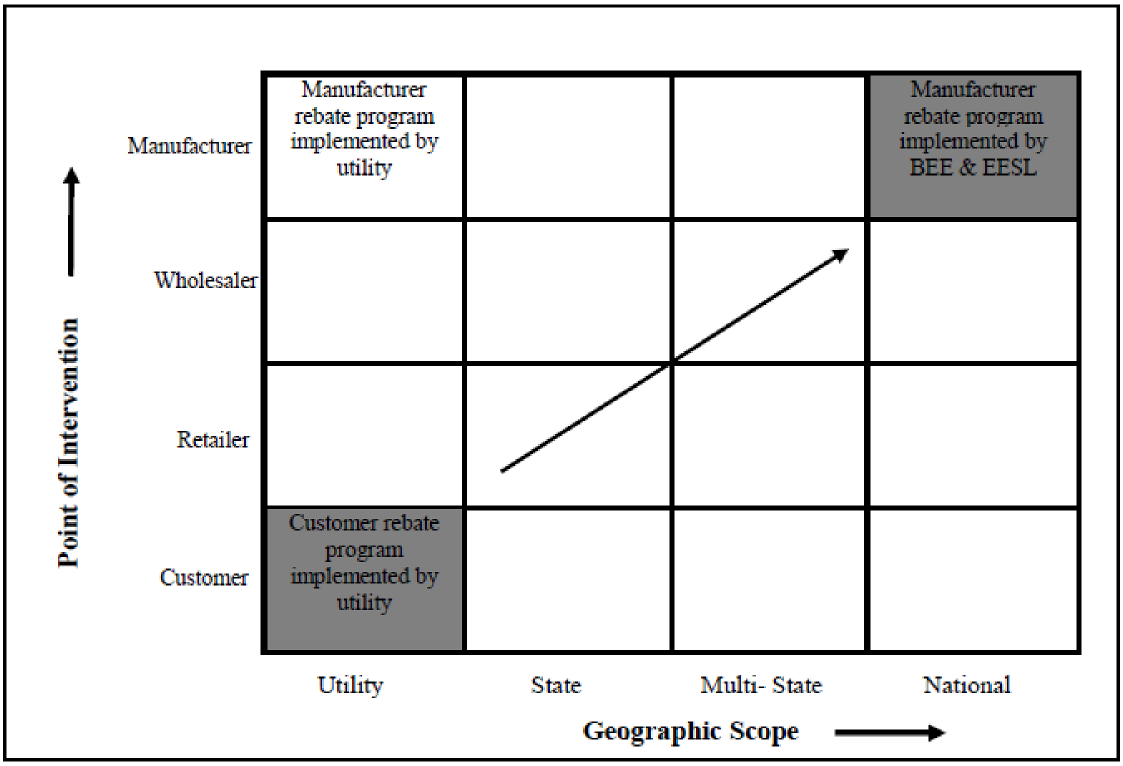
[9] For a more detailed discussion on NPs, please see the paper which we will be presenting at the eceee Summer Study in June 2011: Daljit Singh, Ranjit Bharvirkar, Saurabh Kumar, Girish Sant and Amol Phadke, *Using National Energy Efficiency Programs with Upstream Incentives to Accelerate Market Transformation for Super-Efficient Appliances in India*.

[10] SEAs will of course need to be distinguished in the market through their own labels. This could be done either through endorsement labels as is done in the U.S., or a label based on an extension of the current star labeling program of BEE, where an SEA label would be for, say 7 (or more) stars.

- **Reduced Transaction Costs and Greater Effectiveness**: As Figure 4 shows, the number of transactions decreases as we expand the geographical scope of the program from the utility-scale to the national-scale. The number of negotiations between each utility and various manufacturers would be substantially larger than the number of transactions between just one entity, BEE and the various manufacturers. Similarly, the number of transactions decreases as the point of EE program intervention moves from customer to manufacturer. Customer decision-making with respect to appliance purchases is driven by various factors such as cost of appliance, utility value, usability, aesthetics (e.g. size, color, form, etc.), brand value, potential future energy savings, and others. In contrast, the manufacturer's decision-making process is entirely driven by just one factor, profit. Clearly, influencing millions of customers with varying decision-making criteria is likely to be significantly more expensive than influencing at most a few hundred manufacturers with only one decision-making criterion.
- **Facilitation of Increased Consumer Awareness:** Because a single national entity such as BEE or EESL will have greater credibility with consumers and greater resources at its disposal, it will be able to run a much more effective campaign to increase consumer awareness of energy efficiency and super-efficient appliances. Such awareness is likely to further increase consumer demand for SEAs and thus accelerate market transformation.
- **Relatively Easy Monitoring and Evaluation (M&E):** The payment of incentives to manufacturers will be based on the number of efficient appliances that are sold to consumers, using a deemed savings approach. This will be relatively easy to monitor. In contrast, for utility-administered programs, regulators often require that causality for the energy efficiency savings be established requiring more involved evaluation that has to be carried out by each utility separately.
- **Introduction of Super-Efficient Products and Products Better Suited to Indian Conditions**: There are many products that are based on designs that may not be best suited for Indian conditions. One example is of products such as tube-lights that do not operate well under varying voltage conditions prevalent in many parts of India. Another example is the ceiling fan which is not a priority appliance in most developed countries. However super efficient fans are a priority for India with India producing 40 million fans annually. For such products, manufacturers do not have a sufficient incentive to design and market products suited for Indian conditions because manufacturers do not expect a sufficiently large market initially which would mean higher prices, which in turn, keeps the market for such appliances small. In such cases, an upstream incentive program can facilitate the development of appropriately designed appliances.

Figure 4: Comparison of national program with utility-administered program



While NPs potentially can greatly accelerate the market transformation to highly efficient appliances, there are some potential pitfalls too that must be avoided. Because of the centralization of efforts, a failure of any kind in an NP could have much greater ramifications. In order to tackle these concerns, there will have to be much greater transparency in the implementation. In addition, evaluation, monitoring and verification (EM&V) of NPs will have to be designed carefully and implemented vigilantly. While some of the routine monitoring is likely to be done by EESL, periodic evaluation and monitoring too will have to be implemented by an independent third party.

Recognizing the urgent need to rapidly increase the efficiency of appliances, BEE has been actively promoting the introduction of NPs[11]. As a result, NPs have received in-principle approval from Forum of Regulators (FoR), a statutory body comprising of chairmen of all State Electricity Regulatory Commissions. BEE is now working on developing the implementation mechanism for NPs

[11] *Ascendancy of energy efficiency in India's Policy Landscape*, BEELINE, quarterly newsletter, Issue-1, Oct. 2010.SEEP (Super-Efficient Equipment Program) is BEE's program under which NPs will be developed.

Other Consumer Categories and End-Uses

As stated earlier, we have discussed appliance efficiency in greater detail because we have done more work on the subject. As the priority analysis done in Section 3 shows, there are of course other areas of energy use where improvement in EE is urgently required – building shells (both commercial and residential), industry and agriculture. This section highlights some of the issues that need to be considered, as starting points for the development of suitable approaches for scaling-up EE efforts in these areas of energy use.

Building Shell Improvements - Commercial

As discussed earlier in Section 3, in the commercial sector the potential for energy savings is far greater for new buildings, and therefore, we need to focus on new buildings. This section argues for narrowing the focus a bit more to certain segments in new commercial buildings and then discusses different approaches that could be considered such as labeling (both voluntary and mandatory),and using tariffs and incentives for builders to incentivize construction of efficient buildings.

We review consumption by type of commercial building, in order to identify priority areas within the commercial category of consumers. Satish Kumar et. al. of ECO-III estimate floor space and electricity use for various types of commercial buildings.[12]They use data from Ministry of Statistics and Programme Implementation (MOSPI) on number of enterprises and employees in the various sub-categories of commercial consumers. As with the MOSPI data, their analysis divides commercial consumers into two categories: (1) *Own Account Enterprise* which is an enterprise that is owned and run by an individual or a family without any hired employees; and (2) *Establishment* which is a larger enterprise, with hired employees. Using data on the floor space and the electricity consumption per enterprise or establishment, they estimate electricity consumption for each category of business.

The analysis leads to two interesting results. First, own account enterprises account for only 11% of the electricity consumption. Consequently, for EE efforts, we need to focus on "establishments." The second interesting result, as shown in Table 2, relates to the share of electricity consumption. Four sub-categories: (1) Retail trade; (2) restaurants and hotels; (3) education; and (4) public administration and government offices consume about 60% of the electricity of the commercial category. So it would be best to focus on sub-categories such as these as priority areas. In other words, **it may be advantageous to avoid complicated or sensitive sub-categories such as hospitals in the initial intervention**. Further, BEE could use these results to schedule its labeling program for buildings (which is discussed in the next paragraph), to cover first those sub-categories of commercial establishments that have a greater share of energy consumption.

[12]Satish Kumar, Ravi Kapoor, Aalok Deshmukh, Madhav Kamath and Sanyogita Manu, *Total Commercial Floor Space Estimates for India*, USAID ECO-III Project, New Delhi, June 2010.

The current approach to improving the EE of commercial buildings is based on creation of a norm or a standard (ECBC) and labeling (star rating program for buildings). While the norm is currently voluntary, making it mandatory for new buildings is being discussed. Use of mandatory norms, is a heavy-handed approach without any financial incentive for builders and flat owners to build efficient structures. Given the lax implementation of building rules in most urban areas, there is a danger that this may lead to limited compliance and substantial increase in corruption through 'inspector raj'. Although it has the advantage of necessitating submission of designs compatible with ECBC norms, which is expected to result in a great number of architects becoming familiar with efficient design of buildings.

An alternative or supplementary strategy, that is more incentive-compatible and thus is more likely to succeed, is to use incentives through regulators and utilities. This could be implemented by linking connection charges (hook-up or supply-line charges) and electricity tariffs with the efficiency of the building. Such a scheme would involve utility metering system and align utility interests to identify inefficient buildings and monitor their consumption. Existing institutions such as SERCs, utilities and MoP can develop and implement such a strategy for large buildings after BEE's labeling program for buildings is implemented. Labeling will also create a brand image for efficient buildings, and could increase the demand for them.

A third approach is to ensure that builders constructing efficient structures are given an incentive. The completion of ultra-efficient buildings can be expedited by giving priority in electricity connections or they can be offered a higher Floor Space Index (FSI).

In summary, given the very high growth rate of commercial consumption, focusing on retrofits is less fruitful than development of incentives and systems to ensure that new commercial buildings are built efficiently. An appropriate combination of multiple approaches being discussed needs to be urgently arrived at for scaling-up the implementation. Development of such schemes would be best done through multi-stakeholder consultation so that lessons from past experiences, within India and abroad, can be incorporated

Building Shell Improvements –Residential

Building shell improvements for residential buildings may be a little slower than commercial buildings because each dwelling is relatively much smaller and there are many more owners and/or builders. In addition, residential consumers are more conscious of the initial cost of the building or flat. However, we anticipate that large residential complexes can be clubbed with commercial buildings and then the strategies for commercial buildings outlined above could apply to them.

For smaller residential buildings, a three-pronged approach could be tried. First, increase awareness among architects and builders about the key features to achieve most efficiency gains. Second, modify the building rules in conformity with energy efficient design practices. Third, increase awareness among consumers about how building orientation and design can affect comfort and energy consumption.

Table 2: Electricity Consumption by Sub-Categories of Commercial Establishments

Sub-Category	Services Covered	Elec Use (TWh) 2005	Percent Share	Cumul. Share
Retail Trade	Household items, grocery, pharmacy, vegetables, home appl and electronics	6.143	21.9%	21.9%
Education	Coaching centers, adult ed, driving school, schools and universities	4.796	17.1%	39.0%
Restaurants & Hotels	Street level and urban restaurants, hotels, guest houses	3.715	13.2%	52.2%
Public Admin, Defence, Soc Sec	Offices for govt services, defence, judiciary, municipalities, law and order, fire services	2.962	10.6%	62.8%
Transport & Storage	Offices for customer and maintenance services for road transport, cargo handling, warehouses	1.939	6.9%	69.7%
Health & Social Work	Hospitals and clinics, nursing homes, primary healthcare facilities	1.915	6.8%	76.5%
Wholesale Trade	Same as retail trade	1.896	6.8%	83.3%
Real Estate, Renting, Business Serv	Private offices, real-estate activities (buying and selling, renting, management)	1.393	5.0%	88.3%
Other	Not covered elsewhere	1.361	4.9%	93.1%
Other Community, Social, Pers Serv	Facilities for sewage and refuse disposal, sanitation, religious and poliitical organizations, coop societies (non-housing)	1.182	4.2%	97.3%
Financial Intermediation	Banks and financial institutions, money lenders and agents	0.464	1.7%	99.0%
Post & Telecom	Telephone, post, couriers, SIM card sellers	0.283	1.0%	100.0%
TOTAL (Establishments Commcl)		28.050	100.0%	
Source:	*Total Commercial Floor Space Estimates for India*			
	Satish Kumar et. al. USAID ECO-III Project, June 2010			

Industry

As seen from Figure 3, energy efficiency potential is the greatest in the industrial sector. New additions specially are likely to have a very high saving potential. The industry sector can be divided into three categories: (1) about 560 energy intensive industrial units consisting of large plants (notified under Energy Conservation Act 2001, as 'designated consumers') that account for the bulk of energy consumption in this sector; (2) about 6 lakh[13]industries with High Tension (more than 11 kV) connections but not included in the

[13] This represents the industrial consumers supplied by utilities.

first category, and (3) a very large number of small and medium enterprises (SMEs). Given the wide variation in the characteristics of these three categories, a different approach for improving EE needs to be tailored for each of them.

Designated consumers: Since liberalization of the electricity sector, cost of electricity for these consumers has been reduced through a reduction in cross-subsidy and the setting up of captive power plants[14] by these industries. This has led to a reduced financial incentive for EE.

BEE has introduced the Perform Achieve and Trade (PAT) scheme for these large industries to incentivize the required retrofits in existing industries. This is timely and essential. At the same time, it is even more important that new inefficient units are not set up and that new industrial units in India match the world's standards adjusted for Indian conditions of raw-materials and product mix. Therefore, minimum efficiency (a cap on specific energy consumption) norms need to be established for new units. It is envisaged that the PAT scheme will also cover new units; it should be ensured that the norm for efficiency of new industries receives focused attention.

HT industries other than designated consumers: Developing an appropriate approach for improving the EE of this category is more challenging because of the large number and heterogeneous nature of the group of consumers. Most HT industries are still paying the utility regulated tariff and therefore have a financial incentive to improve efficiency[15]. Measures such as special drives to improve specific energy-intensive operations, benchmarking, increased awareness among management, and increased use of ESCOs in these industries can help

SMEs[16]: On one hand, the EE of SMEs is generally poor implying greater scope for improving the efficiency of these units. On the other hand, there are significant barriers due to lack of information, expertise, and finance to implement EE solutions. A variety of solutions such as the establishment of regional energy efficiency centers (REECs) and consortia to develop solutions, taking a cluster based approach for EE implementation have been suggested.

Agriculture

As Figure 3 shows, retrofits are much more important than new installations in the agriculture sector. The saving potential from agriculture is smaller than other consumer categories, but improving EE in agriculture is important for other considerations such as, reducing the large subsidies in electricity tariffs for agricultural consumers. Improvement in EE of agricultural pump-sets is a necessary component of the strategy to ensure a reliable

[14] Which is much less expensive than the present utility tariff of over 10 US cents per kWh.

[15] Even if they move to 'open access', they may have to pay stand-by and connection charges, and their tariff many not reduce much. In some cases, these industries also need to pay the cross-subsidy surcharge, further reducing their tariff benefit.

[16] Source: USAID ECO-III Project, *Implementation of Energy Efficiency in SME Clusters*, February 2009.

supply of electricity to agriculture, which in turn can reduce undesirable practices such as running pumps whenever there is electricity.However, because pump owners lack sufficient incentive to use efficient pumps and a significant part of the pump industry falls in the unorganized sector, approaches that rely primarily on strict standards and penalties for non-adherence may not work, and instead more incentive-based approaches may be more effective.

Some studies have reported improved outcomes if the pump-set rectification is a part of larger water-energy strategy. But such interventions are more complicated and have been rare. A thorough analysis of past experience is needed before recommendations can be made on this issue. A compilation of studies and field interventions to achieve agricultural pump efficiency was done in an IEI-Prayas report as a part of this process.[17] Alternatives such as payment of cash subsidy directly to consumers combined with electricity tariff reforms, and ground-water regulation have also been suggested.

BEE is running a program to replace old pumps with new energy efficient pump-sets (EEPS), and paying for these investments through the financial saving by the utility due to avoided subsidy payments. The expected saving are in the range of 35 to 40%, with a pay-back period of 3-5 years. An alternative to such a scheme based on pre-mature retirement of pumps could be a national program (NP) for promotion of highly efficient (say 5-star) pumps similar to NPs described for appliances earlier. As old pumps are replaced, the fleet efficiency of pumps would improve. The economics of such a scheme would be far better, as the NP would include payments for only the incremental cost of manufacturing the efficient pump.

The feasibility and economics of promoting super-efficient pumps, having erosion preventive coating on impellers, flat efficiency curves, and possibly multi-speed motors (to maintain high efficiency with changing depth of ground water) need to be evaluated.

Conclusions and way forward

If we are to meet the electricity needs of a rapidly-growing India, EE should occupy center stage in electricity planning and be seen as indispensable as the addition of generating capacity itself. Implementing this vision will require focused attention on key areas and design of schemes that can facilitate rapid scaling-up of implementation. Equally important, the schemes must be designed creatively to meet the challenges of the Indian EE environment - limitations of human resources, financial resources, and institutional capacity.

In order to facilitate the targeting of the country's EE efforts, we carried out a broad brush priority analysis to see how we could get the "maximum bang for the buck." Our analysis

[17] *Efficient well-based irrigation in India: Compilation of experiences with implementing irrigation efficiency* -- Report by the International Energy Initiative (IEI), Bangalore, and Prayas Energy Group, Pune, September 2010

reveals that new additions in industrial, residential and commercial consumer categories have the highest saving potential. The potential savings from retrofits is considerably less. In addition, retrofits are likely to be more expensive and difficult to implement. In the commercial sector, the relative benefits of focusing on new additions are so much greater that we think that for the commercial category, given the limited human resources we have, only new construction should be considered seriously for EE efforts. In contrast, for agriculture retrofits are more important than new additions. Even though the saving potential for agriculture is lower than for other consumer categories, agriculture EE improvement is important for other reasons such as reducing the large subsidies in electricity tariffs for agricultural consumers. It may be useful to see to what extent the country's current policies and focus of the various stakeholders for enhancing energy efficiency sufficiently cover the high priority areas.

For mass-marketed appliances in both residential and commercial consumer categories, up-stream intervention for market transformation through national or multi-state programs appears to be the appropriate scheme. BEE is promoting a national scheme called SEEP (Super Efficient Equipment Program). SEEP has two main features: (1) The geographic scope is expanded from the city or state boundaries to cover the entire country; and (2) The focus is on changing manufacturers' behavior through upstream financial incentives instead of trying to change the behavior of millions of consumers through downstream intervention. Such a scheme is likely to result in a rapid market transformation towards SEAs and will also allow faster up-gradation of minimum efficiency standards, as a majority of the manufacturers participate in SEEP. The scheme anticipates limited (or no) responsibility on the state regulators and the power utilities, and simplifies the monitoring and verification by restricting it to the sites of manufacturers and wholesalers.

We have discussed appliance efficiency in greater detail because we have done more work on the subject. In addition, we have highlighted some of the issues that need to be considered, as starting points for the development of suitable approaches for scaling-up EE efforts in other areas of energy use where improvement in EE is urgently required – building shells (both commercial and residential), industry and agriculture.

For the commercial consumer category, in addition to focusing efforts on new additions, we also suggest focusing on large consumers in four sub-categories: (1) Retail trade; (2) restaurants and hotels; (3) education; and (4) public administration and government offices consume about 60% of the electricity of the commercial category. So it would be best to focus on sub-categories such as these as priority areas. In other words, it may be advantageous to avoid complicated or sensitive sub-categories such as hospitals in the initial intervention.

In addition, we suggest that it may be better to focus on approaches that use positive incentives (reduced tariffs, hook-up charges, etc) rather than solely depending on mandatory compliance with strict standards with penalties for non-compliance. These positive incentives will facilitate rapid up-gradation of mandatory standards.

For industrial consumers, we suggest a three-way division into: (1) designated consumers from energy intensive industries; (2) HT consumers who are not designated consumers; and (3) SMEs. These sub-categories have different characteristics and therefore each of them requires an EE approach tailored for that sub-category. For existing designated consumers, we think PAT is a good scheme. However, we think that there must be a strong focus on ensuring that new units begin to approach the efficiency levels of the world's best industries.

Deepening the analytical discourse to find ways for rapid up-scaling of EE action in India is urgently needed. We hope this paper will help enhance this much needed debate. This paper is intended as a starting point for discussions on this subject and we look forward to comments and continued discussions with all interested stakeholders.