Using national energy efficiency programs with upstream incentives to accelerate market transformation for super-efficient appliances in India

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Abstract

Utility-administered demand-side management (DSM) programs in India have been slow in achieving the shift to efficient appliances. Some of the reasons are: (1) lack of expertise in DSM in utilities and regulatory commissions; (2) utilities being preoccupied with other issues such as electricity shortages and high distribution losses; (3) reluctance of most utilities to propose and design programs on their own. An alternate approach is required to bring about rapid gains in energy efficiency of appliances.

One promising approach is national programs (NPs) with a focus on market transformation through incentives to manufacturers to develop and sell super-efficient products. The design of NPs and the monitoring and evaluation (M&E) plans, and much of the implementation will be done by a national agency, considerably reducing the burden on utilities and state regulators and bypassing many of the difficulties with utility-administered programs. The funding for the incentives can come from ratepayers or taxpayers.

NPs are expected to have several other benefits: (1) reduced transaction costs because interactions will be with a small number of manufacturers rather than millions of consumers; (2) rapid ratcheting-up of efficiency standards; (3) upstream incentives (to offset higher manufacturing costs) that are considerably smaller than customer rebates (to offset higher retail prices); (4) easier monitoring and evaluation; and (5) possibility of introducing products that are not only super-efficient but also better suited to Indian conditions.

NPs have received in-principle approvals from the relevant government agencies. The authors are working with the government agencies to develop the institutional framework, financing mechanism, and monitoring and evaluation that are described in the paper. India's experience with NPs may be relevant for other developing countries that are striving to bring about a market transformation to efficient appliances but have limited expert resources in energy efficiency programs.

Introduction

With growing concerns about climate change and India's energy security, there is an increasing recognition of the benefits of energy efficiency (EE) in addressing these concerns. In 2001, the Government of India (GoI) passed the Energy Conservation Act (ECAct, 2001) and the following year established the Bureau of Energy Efficiency (BEE) under its provisions. The primary objective of BEE is reducing the energy intensity of the Indian economy with participation of all stakeholders leading to rapid and sustained adoption of EE in all sectors (BEE, 2011). In addition to being responsible for making recommendations to GoI for standards and labels on appliances, BEE manages and implements provisions of the ECAct related to: industrial energy consumption benchmarks; energy conservation building codes; energy use in energy-intensive industries; and certification of energy auditors and energy managers. BEE has decided to use a market based approach to standards and labels (S&L). Initially, labels for a product are voluntary until about 50 % of the market starts using labels. Then labels will be made mandatory. The lowest rated label would then become the minimum energy performance standard (MEPS). Further,

the energy thresholds for the labels are to be made more stringent every 2–3 years resulting in on-going improvements in energy efficiency. Currently labels have been introduced for fourteen products. For four products (frost-free refrigerators, room air conditioners (ACs), fluorescent tube lights and distribution transformers) labels have been be made mandatory. BEE uses a star rating system for indicating the energy efficiency of labeled products with 5 stars being the most efficient and one star the least efficient.

In 2010, GoI also established Energy Efficiency Services Limited (EESL), a company to implement EE schemes, programs and policies of central and state governments and their agencies and to help develop a viable Energy Service Company (ESCo) industry. EESL is expected to work as an ESCo and partner with private ESCos, a consultancy organization for energy efficiency, and as a resource center for capacity building of various institutions in the energy sector. Thus for energy efficiency, BEE provides policy and regulation support to GoI, and EESL is the implementation arm.

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[1] in their respective jurisdictions. The Forum of Regulators (FoR) created under the Electricity Act (2003), consists of chairpersons of all State Elecriticity Regulatory Commissions (SERCs) as members and the Chairperson of the Central Electricity Regulatory Commission (CERC) as chairperson. FoR works on developing an uniform and coordinated approach to various issues faced by the Commissions (FoR, 2008). The forum formed a Working Group on DSM and Energy Efficiency which in its report, made recommendations to the SERCs regarding a variety of issues such as: (1) tariff structure to promote EE and DSM; (2) financing of DSM; (3) incentives to encourage utilities to carry out EE and DSM; (4) implementation methods for utility-administered DSM; and (5) capacity building (FoR, 2008). However, only a few SERCs in states like Maharashtra and Delhi have taken any significant steps to promote energy efficiency (Prayas, 2010). In these states, some utilities have initiated programs, mostly for subsidized sale of CFLs, T-5 tubelights, ACs and fans, where the utility recovers the cost of the programs through the annual revenue requirements which form the basis of tariffs. Even the recent utility programs in India are small and can be classified as pilot programs. Further, some of the early programs of CFLs have had high failure rate of lamps (Prayas, 2007) and many programs lack proper monitoring and verification.

Thus we see that the development of DSM programs and the shift to efficient appliances in India has been sluggish. Some of the reasons for the slow development are: (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.

1. Except for the two states of Orissa and Delhi, distribution utilities in states are mostly owned by the respective state government and there are 3–4 of them in each state. In addition, some cities (Mumbai, Kolkota, Ahmedabad and Surat) are serviced by private distribution companies.

Another route for improving appliance efficiency is through a S&L program that BEE has been developing. While for some appliances there is an encouraging shift to more efficient models, for many others new buyers still buy inefficient but less expensive models. For example in 2009–10, for frost free refrigerators, almost 90 % of purchases of labelled products were of 4 or 5 Star models (NPC, 2010). However, for room air conditioners (ACs), only 14 % were 4 or 5 Star rated products while 55 % were 1 or 2 Star rated models. Furthermore, for appliances for which labeling is not yet mandatory, a large fraction of purchases are of unlabeled models.

In addition to the slow adoption of more efficient labeled products, the energy consumption thresholds for labeled products have not been made more stringent as rapidly as earlier expected. One reason for this has been resistance from manufacturers particularly in the unorganized sector which may have difficulty in shifting to improved manufacturing technologies. Furthermore, there is still a very large difference in the energy consumption between the best available technology and current 5 Star level appliances in India. Because most Indian consumers are very conscious of the inital cost of an appliance, higly efficient but more expensive models are not sold in the Indian market. Table 1 gives the difference for the four appliances that are responsible for about half the consumption in Indian households.

Chunekar et. al. of Prayas (2011) estimated the technical saving potential of moving to SEA with respect to a moderate S&L program. The saving potential is calculated based on 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) 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 labelling scenario. This amounts to a reduction in 2020 of about 15 % of residential electricity consumption just from four appliances.

Given the multiple threats arising from increasing energy use – insufficiency of resources, local pollution and climate change – there is an urgent need for a much more rapid improvement in EE. An alternate approach is needed 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 large 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) provide a promising alternative with a focus on market transformation through incentives to manufacturers to develop and sell super-efficient appliances (SEAs). In the next section, we describe 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. Then we describe the institutional mechanism that is proposed to implement NPs. We follow that with a brief report on the status of NPs in India.

Contents Keywords Authors

Table 1: 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

National programs for super-efficient appliances

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 a national agency, 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 entity that designs the DSM program, implements them, and arranges for M&E could substantially reduce the burden on utilities and regulators.

An additional feature of NPs that we are proposing for India would be incentives to manufacturers' for selling SEAs. The required incentive for such an NP is expected to be considerably lower compared to an equivalent utility-adminstered program for two reasons. First, giving upstream incentives avoids wholesale and retail mark-ups and taxes. Second, one entity negotiating 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, the 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. In the next section, we discuss how the incentive level will be set.

Proposed institutional framework

We now look at how such programs can be carried out. We discuss the required institutional framework and the roles and responsibilities of the various stakeholders. The key sources of financing the DSM activities proposed here are either the tax-payers or rate-payers. Various entities will be involved in directing these cash-flows to achieve the DSM goals. The size of these cash-flows is also likely to be enormous. Given this complexity and high stakes, in order to establish trust and sustain it over the long-term it is necessary to define an institutional framework for NPs that results in transparency and accountability with respect to all of its operations. Examples of mechanisms that promote transparency and accountability include public hearings, bidding for contracts, and others.

We start with the various functions that would need to be carried out. These are: (1) overall oversight of the program; (2) program design; (3) program implementation and monitoring; and (4) verification and process evaluation. Table 2 provides more details on the tasks that are involved in each of these four major functions. In addition, we have provided the agency that we think would be most appropriate to perform each major function.

OVERALL PROCESS FOR IMPLEMENTING NPS

Figure 1 shows the flowchart of the proposed process for implementing NPs. In the following paragraphs, we provide details of some of the blocks of the flowchart.

Selection of equipment and setting of specifications for super-efficiency

From time to time, based on an assessment of the market and the energy efficiency potential of various appliances, BEE will prepare a priority list of appliances for a NP. For each appliance, BEE will set up a Technical Committee comprising of stakeholders from relevant Government agencies, Bureau of Indian Standards (BIS), Manufacturer / Industry Associations, Testing Laboratories, Consumer Groups, etc. The Technical Committee will recommend technical standards that would meet the objectives of advancing energy efficiency standards of the particular appliance. The technical committee will also specify testing protocols, identify test laboratories and assess gaps in testing infrastructure.

Table 2: Roles and Responsibilities.

Program Function	Responsibilities	Responsible Agency
Oversight	Overall oversight Initiate Program Development Ensure program goals being met	FoR
Program Design	Decide which appliances/end-users to focus on Develop specs for products and estimate required incentive	BEE
Program Implementation and Monitoring	Contracting with manufacturers Monitoring sales of SEE by state	EESL
Verification and Process Evaluation	Verify sales of SEEs Evaluate effectiveness of program processes and administration	Independent third party hired by FoR

Adapted from Blumstein et.al. (2003)

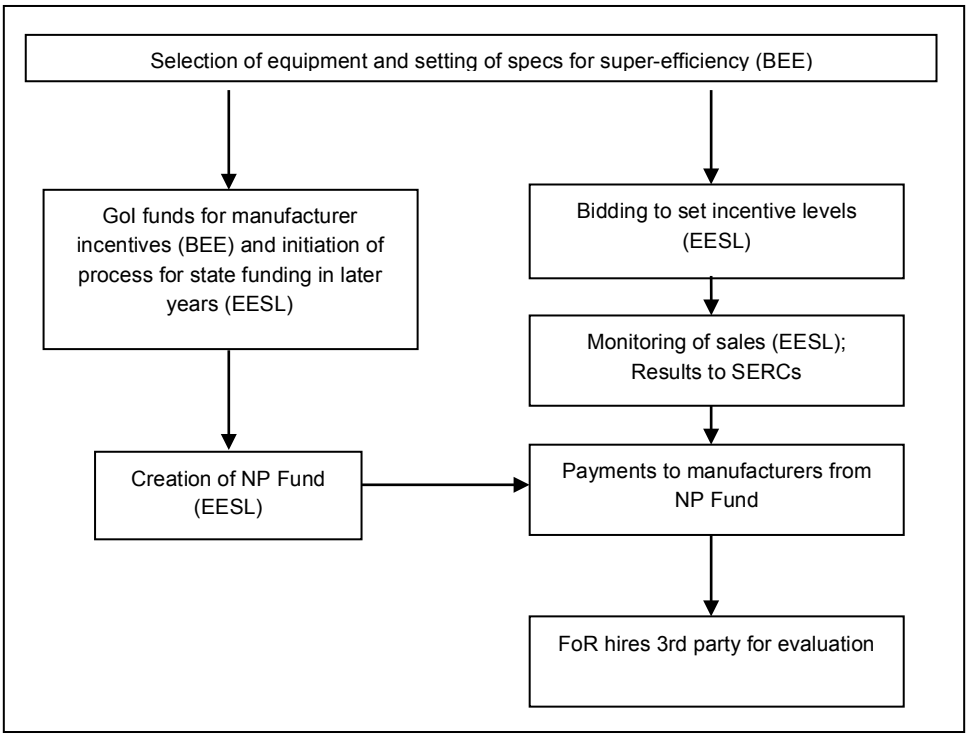

Figure 1. Overall Process for Implementing NPs.

Bidding to set incentive levels

Once the appliance for a NP is selected, the incentive will be set based on the minimum-bid for the subsidy required by a manufacturer through a competitive bidding process. The bidding for the lowest incentive has to overcome the twin challenges of competitive price discovery while avoiding that the entire order goes to one single manufacturer. Our proposed approach to the bidding given in the next paragraph attempts to fulfill these requirements. The final bidding process will be decided after additional discussions with manufacturers.

In order to provide an incentive for manufacturers to bid low, the lowest bidder would get a certain premium (say 20 %) above his bid in the first year. All the other bidders who fall between the lowest bid and 120 % of the lowest bid would get 110 % of the lowest bid. The remaining bidders whose bids are higher than 120 % of the lowest would get no incentive in the first year. From the second year on, all manufacturers would get an incentive equal to the lowest bid. The lowest bidder, who sets the price would be required to sell a certain amount (3-5 % of the overall sales) in the first year, else would lose a predetermined deposit amount. In order to protect consumers from excessively high bids, EESL will hire a consultant to estimate the incremental cost of manufacturing the SEA. This estimate will inform the setting of a reasonable range for the incentive. If no bids are received in the reasonable range, EESL will be free to cancel the bidding process. The program can be approved for

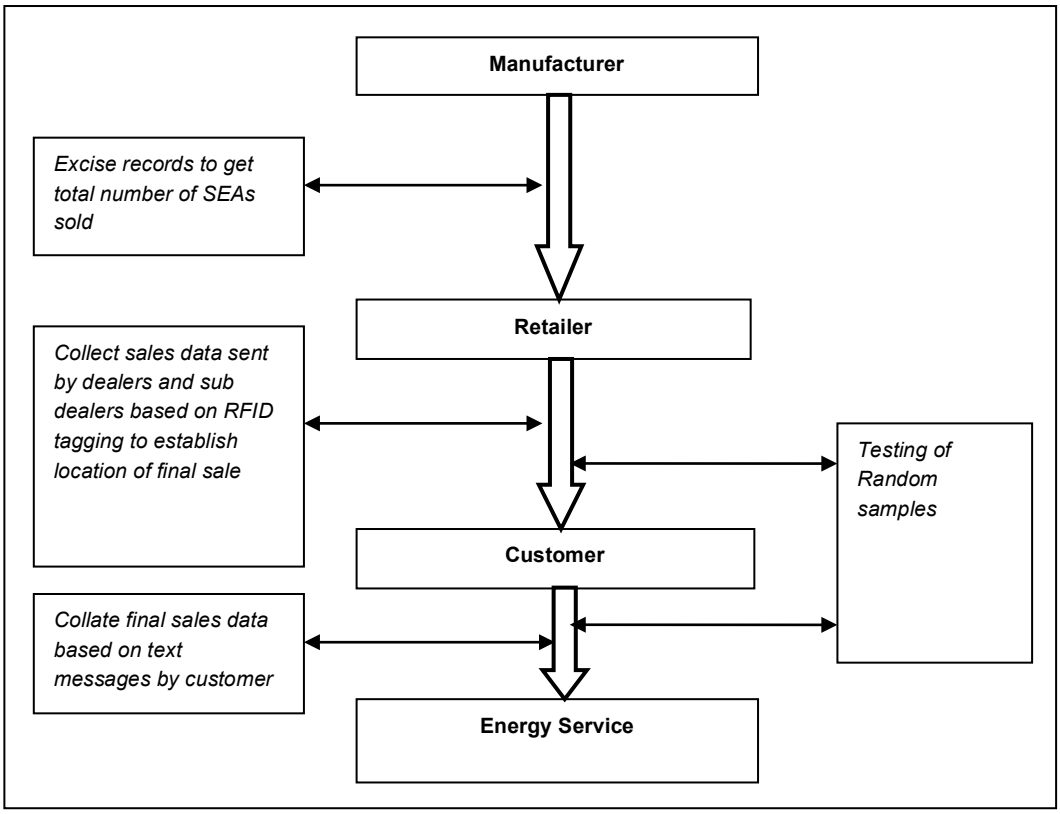

Figure 2. Framework for Monitoring of NPs.

a multi-year period but it is recommended that the bidding for price discovery be undertaken by EESL annually so as to take the advantage of price reduction.

Monitoring and evaluation of NPs

A deemed savings approach will be used for NPs, and incentives will be based on the number of SEAs sold by manufacturers. Furthermore, because the payments by a state will be based on the sales in that state, the number of SEAs will have to be determined state-wise.

Thus the monitoring needs to address two concerns: (1) the validity of the number of SEAs sold by each manufacturer in each state; and (2) the quality and performance of SEAs sold under the program. Figure 2 shows our proposed monitoring framework for NPs that addresses these two concerns. The left side of the diagram is designed to facilitate the validation of the number of SEAs claimed to have been sold by the manufacturers. As shown it does this at three levels – manufacturer, retailer, and customer – providing some redundancy. Not all consumers will send text messages, so the numbers based on text messages from the customer may understate the number of appliances sold. However, they will provide a reasonableness check on estimates from the excise records and data sent by retailers. More important, they will facilitate testing of the SEAs by identifying most of the consumers who have bought the SEAs. The right side of the figure shows the measures proposed to be taken to ensure that the quality and performance of the SEAs meet the required specifications. These tests of random samples is something that BEE already does for checking the validity of labels under its S&L program, and therefore would not be particularly burdensome.

Funding

There are two potential sources of funds that are needed to provide incentives to manufacturers for NPs for appliances:

- Allocation from GoI budget
- Recovery from electricity tariff

The two key criteria for assessing these alternatives include: (1) sustainability of funding; and (2) the transaction costs involved in securing the funding.

GOVERNMENT BUDGET ALLOCATION

The main advantage of obtaining funding for this EE effort from GoI's budgets is that only one entity and a small set of decision-makers need to convinced of the benefits of this effort – i.e. smaller transaction costs. In contrast, an effort to convince a majority of the SERC members in each state would need a substantial and longer effort. In addition, the government is already engaged in making critical decisions affecting the overall power sector and hence, would be able to assess this effort in a comprehensive manner in relation with the other decisions, unlike state regulators and policy-makers. For example, investing in EE instead of power generation (e.g. coal, gas, hydro, etc.) is definitely a cheaper and cleaner way of addressing the power shortage in the nation and is on the whole beneficial to all citizens (e.g. clean environment, increased productivity, etc.). The main disadvantage of allocation from the GoI's budget for NPs is that it may not be sustainable as it would compete with other government funding priorities such as education, health, defense, etc.

ELECTRICITY TARIFF RECOVERY

The main advantage of obtaining funding for NPs from electricity tariffs is the sustainability. As long as the benefits of the DSM accrue to the electricity customers, the SERCs are unlikely to discontinue funding the NP through the tariffs unlike the GoI budget allocation.

However, if the source of funds is electricity ratepayers, then the key stakeholders – SERCs, utilities, and customers' representatives – must agree that this use of the funds is appropriate. Unlike the GoI budget allocation, where only a small set of decision-makers needs to be convinced about this program, stakeholders in each state would need to be convinced of the net benefits of the NP. This is a much larger and longer effort as compared with the GoI alternative.

There are various ways of structuring this type of surcharge. One potential design is presented here. A non-bypassable and non-discriminatory "DSM Charge" ensures that even those customers who contract for supply from an alternate supplier pay for improving the efficiency of electricity use in the state. Making the charge consumption-based would ensure that smaller consumers do not find the charge burdensome. The charge can be quite small – for example, a charge of one paisa (~0.017 Euro cents) per kWh nationwide would yield about INR 6 billion (~100 million Euros) per year.

PROPOSED FUNDING MECHANISM

Based on the reasoning given above, we think that in the long run it may be best to have funding from electricity revenues. However, because of the time it may take to obtain all the necessary approvals, we propose that the program be initially funded from GoI funds but then be funded from electricity revenues in the following fashion, to facilitate a quick start for the program and to provide incentives to states to approve use of electricity revenuens:

- In the first year, funds from GoI would be used to start the program in all states.
- In the second year, the program would focus on states where the utilities provide a part of the funding (say 50 %). The remainder would come from GoI funds.
- In the third year and after, the funding would come entirely from electricity revenues.

Benefits of NPs

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, which we discuss next.

REDUCED TRANSACTION COSTS AND GREATER EFFECTIVENESS

As Figure 3 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.

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-adminstered 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 Indian voltage conditions. 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.

Progress on NPs in India

Recognizing the urgent need to rapidly increase the efficiency of appliances, BEE has been actively promoting the introduction of NPs (BEELINE, 2010)[2]. As a result, NPs have received in-principle approval from FoR. BEE is now working on developing the implementation mechanism for NPs.

A similar approach to NPs is being pursued internationally. The Super-Efficient Equipment and Appliance Deployment (SEAD) program seeks to use the bargaining power of the IPEEC[3] countries to improve efficiency of appliances traded world-wide (Phadke et.al., 2010). Many IPEEC countries are already implmenting or exploring incentive programs for efficient appliances. It is hoped that by coordinating standards and labels and incentives, tremendous economies of scale can be created for super-efficient appliances. India is participating in the program.

2. SEEP (Super-Efficient Equipment Program) is BEE's program under which NPs will be developed.

3. The International Partnership on Energy Efficiency Co-operation (IPEEC) was created at the G-8 summit in 2008, and is made up of the G-8 countries and other major economies such as Brazil, China, India and South Africa.

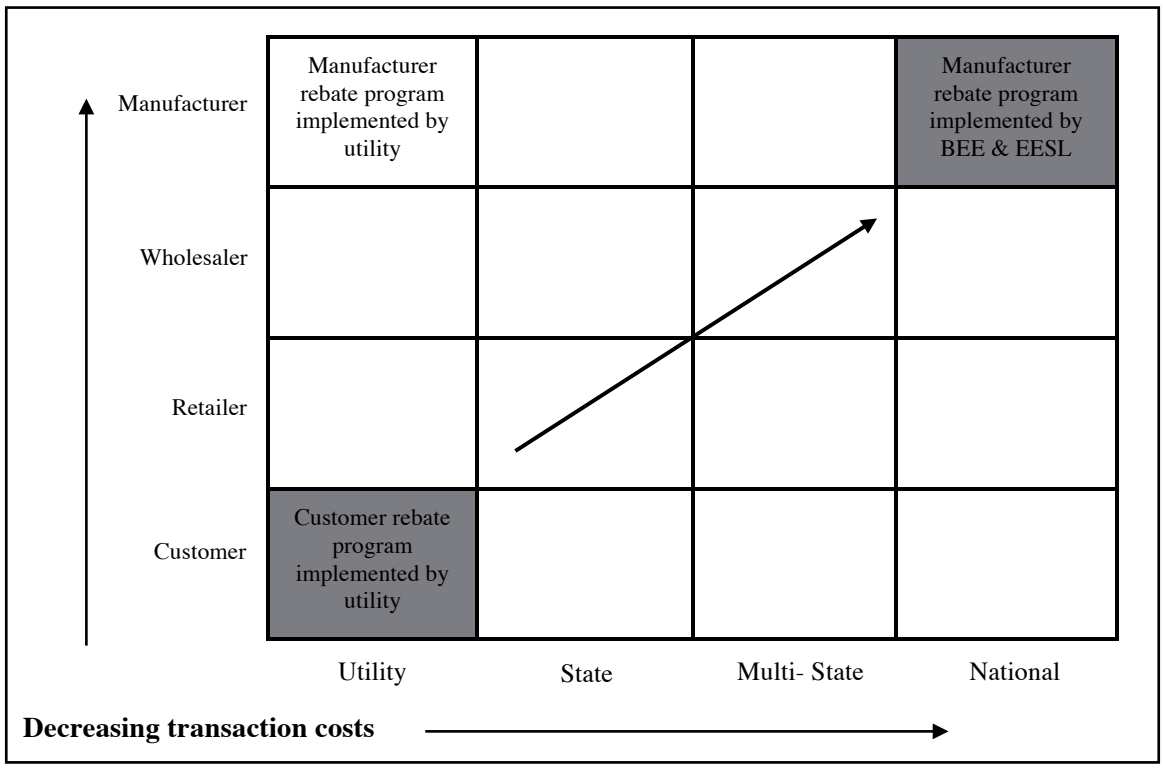

Figure 3. Transaction Costs of NPs and Conventional Utility-Administered Programs.

Conclusions

In spite of concerted efforts to improve the EE of electrical appliances based on labeling and utility adminstered DSM programs, progress has been slow, because of limitations of human resources and institutional issues. There is a large gap in the energy efficiency of the most efficient appliances commercially available worldwide and the most efficient models in the Indian market. In addition, there is a gap between the average efficiency of appliances sold in India and the best available in the Indian market. NPs offer a promising approach to bring about rapid improvements in EE of appliances and narrow both of these gaps, through incentives to manufacturers to develop and sell super-efficient products. By reducing the burden on utilities and regulators for program design and development, NPs bypass problems with lack of capacity and time in utilities and regulatory commissions.

NPs are expected to have several other benefits: (1) upstream incentives that are considerably smaller than customer rebates; (2) reduced transaction costs because interactions will be with a small number of manufacturers rather than millions of consumers, leading to greater effectiveness; (3) easier M&E; and (4) possibility of introducing products that are not only super-efficient but also better suited to Indian conditions.

NPs have received in-principle approvals from the relevant government agencies. The authors are working with the government agencies to develop the institutional framework, financing mechanism, and M&E that are described in the paper. India's experience with NPs may be relevant for other developing countries that wish to bring about a market transformation to efficient appliances but have limited expert resources for energy efficiency programs.

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Glossary

BEE	Bureau of Energy Efficiency
BLDC	Brushless DC
CAGR	Cumulative Average Growth Rate
CFL	Compact Fluorescent Lamp
DSM	Demand-Side Management
EE	Energy Efficiency
EESL	Energy Efficiency Services Limited
ESCo	Energy Service Company
FoR	Forum of Regulators
GoI	Government of India
IPEEC	International Partnership on Energy Efficiency Cooperation
LCD	Liquid Crystal Display
LED	Light Emitting Diode
M&E	Monitoring and Evaluation
MEPS	Minimum Energy Performance Standard
NP	National Program
S&L	Standards and Labels
SEA	Super-Efficient Appliance
SEAD	Super-Efficient Equipment and Appliance Deployment
SERC	State Electricity Regulatory Commission