

A Guidebook on Super-Efficient Equipment Program (SEEP)

December 2013

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December 2013

About Prayas

Prayas (Initiatives in Health, Energy, Learning and Parenthood) is a nongovernmental, non-profit organization based in Pune, India. Members of Prayas are professionals working to protect and promote the public interest in general, and interests of the disadvantaged sections of the society, in particular. The Prayas Energy Group works on theoretical, conceptual regulatory and policy issues in the energy and electricity sectors. Our activities cover research and intervention in policy and regulatory areas, as well as training, awareness, and support to civil society groups. Prayas Energy Group has contributed in the energy sector policy development as part of several official committees constituted by Ministries and Planning Commission. Prayas is registered as SIRO (Scientific and Industrial Research Organization) with Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India.

Acknowledgements

We thank the Clean Energy Ministerial (CEM)'s Super-efficient Equipment & Appliance Deployment (SEAD) Initiative for providing financial support for this work through the Lawrence Berkeley National Laboratories (LBNL). The Bureau of Energy Efficiency (BEE) and, particularly Dr. Ajay Mathur and Dr. Ashok Kumar, have provided encouragement and support throughout the development of SEEP. Stephane de la Rue du Can from LBNL, Matthew Wittenstein from U.S Department of Energy (DoE), and Dr. Mahesh Patankar, Consultant for Regulatory Assistance Project (RAP) provided insightful comments on the guidebook.

The World Bank gave a tremendous fillip to SEEP by facilitating discussions among stakeholders and providing inputs on various aspects of SEEP and making great efforts to take the program forward. We would like to express our special gratitude to the Climate Works Foundation and Shakti Sustainable Energy Foundation for supporting us in the development of SEEP in India. The guidebook would not have been possible without their generous support to our activities related to SEEP.

Shantanu Dixit, Dr. Amol Phadke, Cathie Murray and Robert Lieberman have been there throughout the development of SEEP and provided constant support and advice during the preparation of this guidebook. Adwait Pednekar and Ranjit Bharvirkar provided valuable inputs on technology and policy issues that contributed greatly to the development of SEEP. Last, but the most important, Girish Sant, co-founder of Prayas, played a key role in the conceptualization, development and implementation of SEEP. He passed away un-expectedly in February 2012. We will always miss him.



Foreword

India's high and sustained economic growth is causing a significant demand for electricity putting a tremendous burden on its already resource-strained power sector. Energy efficiency measures have the unique advantage of meeting demand through existing capacity at a lower cost than that of building additional capacity.

Realizing the importance of energy efficiency, Government of India enacted Energy Conservation Act in 2001 which led to establishment of Bureau of Energy Efficiency (BEE). BEE has been successfully conducting several programs like Standards and Labeling (S&L), Energy Conservation Awards, and Bachat Lamp Yojana which has improved energy efficiency across various sectors in India. BEE has also initiated innovative programs under the National Mission on Enhanced Energy Efficiency (NMEEE), one of the eight missions of Indian National Action Plan for Climate Change. One of such programs is Super-Efficient Equipment Program (SEEP).

Appliance sales are booming in India and are expected to grow in future buoyed by economic growth. This in turn is causing a significant increase in electricity consumption by the residential and commercial sector. The primary objective of SEEP is to achieve market transformation to super-efficient appliances, appliances which are significantly more efficient than those available in India. BEE has developed this program for ceiling fans in India and is at an advanced stage of implementation.

I am glad that Prayas has documented the experience of developing SEEP in this guidebook. This guidebook has described a general framework for conducting background analysis and considering different aspects related to the program design and implementation. I am sure this will help policy-makers in other countries to develop similar programs and will provide further impetus to the efforts for transition to a global clean energy economy.

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10th April 2013

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List of Abbreviations

BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BLDC	Brushless Direct Current
BUENAS	Bottom-Up Energy Analysis System
CBECs	Commercial Buildings Energy Consumption Survey
CCE	Cost of Conserved Energy
CEA	Central Electricity Authority
CEM	Clean Energy Ministerial
CLASP	Collaborative Labeling and Standards Program
CMM	Cubic Meters per Minute
CRT	Cathode Ray Tube
CST	Central Sales Tax
CTF	Climate Technology Fund
CWF	Climate Works Foundation
DSM	Demand Side Management
EE	Energy Efficiency
EIA	Energy Information Administration
GDP	Gross Development Product
GHG	Green House Gas
GWh	Giga Watt Hour
ICOR	Incremental Capital Output Ratio
IHDS	India Human Development Survey
IPEEC	International Partnership for Energy Efficiency Corporation
LBNL	Lawrence Berkeley National Laboratories
LCD	Liquid Crystal Display
M&V	Monitoring & Verification
MW	Mega Watt
NCAER	National Council of Applied Economic Research
NSSO	National Sample Survey Office
PEG	Prayas Energy Group
PJ	Peta Joules

RAP	Regulatory Assistance Project
RECS	Residential Energy Consumption Survey
RFID	Radio Frequency Identification
SEE	Super-Efficient Equipment
SEAD	Super-efficient Equipment &Appliance Deployment
SEEP	Super-Efficient Equipment Program
S&L	Standards & Labeling
TWh	Tera Watt Hour
T&D	Transmission & Distribution
UEC	Unit Energy Consumption
VAT	Value Added Tax
W	Watt

Executive Summary

The guidebook provides a framework for policy-makers in different countries to conceptualize, design and implement innovative programs to accelerate market transformation to super-efficient equipment and appliances (SEE). SEE are commercially feasible equipment and appliances significantly more efficient than those available in local markets. The framework is based on the experience of developing a program called Super-Efficient Equipment Program (SEEP) in India. Bureau of Energy Efficiency (BEE) has initiated SEEP for ceiling fans in India. The core idea of SEEP is to provide financial incentives to manufacturers so that they can develop, produce and sell super-efficient equipment and appliances (SEE) at prices comparable to an average appliance. The program is voluntary and manufacturers will bid for the amount of financial incentive as well as the total production quota through a reverse bidding mechanism with a pre-specified cap. The bidding mechanism is developed to allow multiple winners. The incentive will be paid per unit super-efficient fan to the manufacturer after the product leaves the factory for the market. A strict Monitoring & Verification (M&V) mechanism will check the quality and quantity of ceiling fans sold under the program.

The guidebook is not meant to be a strict rule-book but more of a template to develop a SEEP like program in different countries, particularly, developing countries with similar political and institutional mechanisms as in India. The actual development of the program in a specific country will be influenced by a number of local factors.

The first step of the program development is to conduct preliminary analysis to answer fundamental questions related to SEEP. This analysis can be split into four components. In the first component, those appliances can be identified that contribute significantly to the country's total electricity consumption. These appliances can then be the focus of second component of analysis where the saving potential of the super-efficient models of those appliances can be estimated. In the third component, costs and benefits of a SEEP like program that provides financial incentives to manufacturers can be estimated for the selected appliances. Finally, a priority analysis can consider factors other than the total benefits and cost such as nature of the market, technology availability, and political acceptability of a program like SEEP to prioritize the appliances among the selected appliances. The analyses are summarized in the following table.

Appliance consumption analysis	What is the contribution of major appliances to electricity consumption?
Saving potential analysis	What is the saving potential of super-efficient variants of top consuming appliances?
Cost-benefit analysis	What is the benefit to cost ratio of running a SEEP like program for top consuming appliances?
Priority analysis	How to choose the appliance for SEEP considering cost, total saving potential and other factors?

The second step of program development is the program design and implementation. There are some basic principles that should guide the program design. First, the program should be simple and easy to administer. A complex program with bureaucratic hassles will keep the manufacturers away.

At the same time, the program should provide adequate checks and balances since it involves providing financial incentives to manufacturers. It will also be beneficial to involve all the stakeholders including manufacturers in the process of program design. Finally, transparency in decision-making is crucial to ensure accountability. Every decision making process should be well documented. The steps in the program design and implementation, the relevant questions that should be answered at every step and suggested guidelines are summarized in the following table.

Steps	Questions	Suggested Guidelines
Funding	<ul style="list-style-type: none"> • What will be the source of funding: federal government, utility or international finance? 	<ul style="list-style-type: none"> • The funding should be sustainable. • The transaction costs in securing the funding should be minimized.
Technical specifications	<ul style="list-style-type: none"> • What should be the specifications for energy consumption and performance of SEE and how to identify them? 	<ul style="list-style-type: none"> • A technical committee of all the stakeholders including manufacturers should identify technical specifications early in the program design. • The SEE specifications should be a right balance between cost and efficiency. • The SEE specifications should be technology neutral. • The SEE specifications may require a better performance than normal appliance.
Incentive Determination mechanism	<ul style="list-style-type: none"> • How to determine incentives: bidding, uniform incentive or mixed approach? 	<ul style="list-style-type: none"> • Multiple manufacturers should be able to participate in the program. • Incentive level should be the right balance between cost and the potential to maximize savings.
Incentive criteria	<ul style="list-style-type: none"> • Who should participate in the program? • What should be the condition on price of SEE in the market? 	<ul style="list-style-type: none"> • There should be eligibility criteria for manufacturers to participate in SEEP. • There should be a specified maximum retail price for SEE. • Incentives should be reviewed periodically
Incentive disbursement mechanism	<ul style="list-style-type: none"> • What should be the requirement for manufacturers to claim incentives? • How regular should the incentives be disbursed? • What should be the penalty of non-compliance? 	<ul style="list-style-type: none"> • The incentives can be given to manufactures at production stage or at the sales stage. • The choice of disbursal mechanism should be influenced by cost, simplicity and ease of implementation. • The period of disbursement of incentives should be fixed a priori. • There should be performance criteria for manufacturers and severe penalty in case of default. <p style="text-align: right;">..... Contd</p>

Steps	Questions	Suggested Guidelines
Monitoring & Verification	<ul style="list-style-type: none"> • How to verify the quantity of SEE produced and sold by the manufacturers? • How to monitor the performance of the SEE sold by the manufacturers? 	<ul style="list-style-type: none"> • M&V should be conducted for Quality and Quantity of SEE. • Existing mechanism like tax systems can be used to verify manufacturer’s claims on SEE production. • Adequate testing laboratories with appropriate accreditation should be identified. • A testing protocol should be developed for SEE. • Testing mechanism should include one-time conformance or type testing followed by random check testing at manufacturer, retailers and customer level.
Evaluation	<ul style="list-style-type: none"> • How to evaluate the impact of the program? 	<ul style="list-style-type: none"> • Periodic evaluation of SEEP should be conducted by an independent third party. • The savings achieved can be calculated using the deemed savings approach. • Indirect benefits of SEEP should also be measured. • Administrative processes should also be evaluated. • Customer feedback is an essential element of the evaluation.
Branding & Marketing	<ul style="list-style-type: none"> • How to create consumer awareness around the program and market the SEE? 	<ul style="list-style-type: none"> • SEE should have a distinct label with the information on energy consumption and saving. • A creative marketing campaign should be designed to generate awareness among consumers. • Government endorsement on marketing campaign can increase the credibility • Retailers and other intermediate actors should be included in the campaign.
Institutional Framework	<ul style="list-style-type: none"> • How to effectively assign roles and responsibilities of all the functions related to the program? 	<ul style="list-style-type: none"> • The institutional framework should address functions across five categories: (1) oversight of the program (2) program design (3) program implementation (4) monitoring & verification and (5) process evaluation.
Transparency and Accountability	<ul style="list-style-type: none"> • How to ensure transparency and accountability during program design and implementation? 	<ul style="list-style-type: none"> • A website dedicated to SEEP should be created and all the data related to the program should be made available for public. • The program design process should be documented with rationale behind each decision clearly explained. • Program design document should be open to comments from a wider section of society including general public and civil society organizations.

1 Introduction

Appliances and equipment all over the world contribute significantly to the total electricity consumption. In 2011, the buildings and industries were expected to consume about 18,000 TWh of electricity and 375,000 PJ of primary energy globally mostly through appliances and equipment¹. A global scale-up of energy efficient equipment and appliances would cost about 2 to 5 cents per kilowatt-hour saved—a fraction of the cost of clean energy from other sources². Appliance and equipment efficiency therefore has enormous potential to reduce energy demand and carbon emissions while lowering energy costs for consumers, businesses, and institutions.

Although energy efficient appliances are cost effective, there are significant barriers for their widespread market adoption. A number of policies and programs have been implemented by several governments across the world to overcome these barriers. One such program has been initiated by Bureau of Energy Efficiency (BEE) in January 2013 and is called Super-Efficient Equipment Program (SEEP) (see [Box A](#)). BEE is the central government agency in India to implement energy efficiency policies and programs. The core idea of SEEP is to provide financial incentives to manufacturers so that they can develop, produce and sell super-efficient equipment and appliances (SEE) at prices comparable to an average appliance. SEE are significantly more efficient than the most efficient appliances in India but currently not available. However, these SEE are commercially available in international markets and not a lab-concept. BEE has initiated SEEP for ceiling fans in India. Prayas Energy Group (PEG), Pune has been involved in developing and advocating SEEP in India with support from Climate Works Foundation (CWF), Lawrence Berkeley National Laboratory (LBNL) and Regulatory Assistance Project (RAP). This guidebook is supported by the Clean Energy Ministerial (CEM)'s Super-efficient Equipment and Appliance Development Initiative (SEAD) (see [Box B](#)).

In this guidebook, we have developed general guidelines for policy-makers in different countries to conceptualize, design and implement a program like SEEP. These guidelines are based on our experience in developing SEEP in India. The guidebook is not meant to be a strict rule-book but more of a template to develop a SEEP like program. The actual development of the program in a specific country will be influenced by a number of local factors. We have provided specific examples of analyses and processes related to SEEP. The examples are mostly related to India but can be relevant to many other countries, particularly, developing countries with similar political and institutional mechanisms as in India. SEEP has been initiated in India in January 2013 and will be implemented in India's 12th five year plan. There will be valuable lessons from the implementation of the program which may impact some of the guiding principles described here. We intend to document these lessons after SEEP has been run for two years. Nonetheless, we believe the guidelines developed here based on the lessons learnt from the conceptualization and design stage will be helpful to the policy-makers around the world in developing SEEP like programs in their countries. The guidebook

¹ SEAD, The Energy Saving Potential of Appliance and Equipment Efficiency. Available on: <http://www.superefficient.org/~media/Files/the-energy-savings-potential-of-appliance-efficiency.pdf> (Last Accessed 15th February 2013)

² SEAD, Initiative Overview. Available on: http://www.superefficient.org/~media/Files/SEAD_Initiative_Overview.pdf (Last Accessed 15th February 2013)

is based on the work done on the development of SEEP in India. Specifically, it refers extensively to the following documents published by Prayas over the development period of SEEP.

1. Singh D, Sant G, Chunekar A, Pednekar A and Dixit S, *Development of Super-Efficient Equipment Program (SEEP) for fans*, Prayas Energy Group, 2012.
2. Singh D, Bharvirkar R, Kumar S, Sant G and Phadke A, *Using national energy efficiency programs with upstream incentives to accelerate market transformation for super-efficient appliances in India*. Presented at ECEEE Summer Study, BelambraPresqu'île de Giens, France, 2011.
3. Singh D, Sant G, Chunekar A, *Improving energy efficiency in India: need for a targeted and tailored strategy*, WIREs Energy Environ. 2012. doi: 10.1002/wene.45

Box A : Super-Efficient Equipment Program (SEEP) in India

Bureau of Energy Efficiency (BEE), the nodal government agency in India to implement energy efficiency policies and programs, has initiated SEEP on national level for ceiling fans and will be implemented in 12th five year plan. The primary goal of the program is to accelerate the market transformation to super-efficient appliances and equipment in India. The program will be implemented in two phases. The first phase will be funded through Clean Technology Fund (CTF) administered by World Bank. CTF will provide US\$50 million to Government of India for SEEP. The second phase of the program will be funded through budgetary allocation of Government of India (GoI). The program will be voluntary for manufacturers and will incentivize 5 million super-efficient fans in the first phase over a three year period. The super-efficient (SE) fan will consume 35W as compared to the current market average of 70W. The SE fan is also significantly more efficient than the 5 star rated fan (most efficient fan) which consumes about 52 W. The performance of both the fans as measured by air delivery must be same at 210 cubic meters per minute (cmm). The first phase of the program aims to save about 390 million units of electricity annually avoiding a peak capacity of 95 MW. The program will provide financial incentives to manufacturers to cover the incremental cost of producing SE fans so that they can sell them at prices comparable to normal appliances. Manufacturers will bid for the amount of financial incentive as well as the total production quota through a reverse bidding mechanism with a pre-specified cap. The bidding mechanism is developed to allow multiple winners. The incentive will be paid per unit SE fan to the manufacturer after the product leaves the factory for the market. A strict Monitoring and Verification (M&V) mechanism has been designed which will be implemented by an external agency hired through a separate bidding process. Records from Excise Duty, Central Sales Tax (CST) and Value added Tax (VAT) will be used to verify the amount of SE fans produced. The quality of SE fans will be tested according to protocols in IS 374, a standard prescribed by the Bureau of Indian Standards (BIS) for ceiling fans in India, with some modifications. These modifications were made by a technical committee, which included manufacturers, to make IS 374 more rigorous and consistent for SE fans. There will be two types of testing: (a) an initial, one-time, type testing to check the conformance of the product with SE fans' specifications and (b) a periodic random checking on products picked from manufacturer's assembly line and retail shops.

Box B : Super-efficient Equipment and Appliance Deployment (SEAD) Initiative

SEAD³ is a multilateral, voluntary effort among Australia, Brazil, Canada, the European Commission, France, Germany, India, Japan, South Korea, Mexico, Russia, South Africa, Sweden, the United Arab Emirates, the United Kingdom, and the United States. China became an observer in November 2011. It is a five year, US\$20 million initiative under the Clean Energy Ministerial (CEM) and the International Partnership for Energy Efficiency Cooperation (IPEEC). SEAD seeks to engage governments and the private sector to transform the global market for energy-efficient equipment and appliances. SEAD partners are developing a common technical foundation that will enable governments to more easily adopt cost-effective appliance efficiency policies and programs. Broader market transformation efforts, including incentives, awards, and procurement programs, seek to further accelerate the global pace of adopting energy-efficient equipment and appliances. SEAD is supported by the Collaborative Labeling and Appliance Standards Program (CLASP) as operating agent and the Lawrence Berkeley National Laboratory (LBNL) for technical analysis. It has collaborative relationships with ENERGY STAR, the International Energy Agency “Efficient Electrical End-Use Equipment” Implementing Agreement, and Asia-Pacific Economic Cooperation Expert Group on Energy Efficiency and Conservation.

Some of the recent activities under the SEAD initiative are:

Global Efficiency Medal Competitions: SEAD holds global efficiency medal competitions to encourage the production and sale of super-efficient equipment, appliances, and electronics by identifying the most efficient product in each category in four regions, as well as an overall global winner. This winner-takes-all competition spurs innovation among manufacturers seeking to be the very best and guides early adopter consumers who want to buy top-performing products. The first competition was held for flat panel televisions and the winners were Samsung and LG. Their televisions were 33-44% more efficient than televisions with similar technology. The second competition is being held for desktop computer monitors.

Efficient Product Promotion Collaborative: The collaborative, launched in April 2012, aims to strengthen programs targeting efficient and super-efficient products. The Collaborative connects international stakeholders throughout the energy efficiency value chain to inform program design and maximize efficiency benefits at least cost. It focuses on incentive programs, informational campaigns, and award programs—considering their interactions with marketing strategies and existing labeling programs. It aims to leverage the vast existing program design and evaluation knowledge base of its members and share insights internationally.Contd

³<http://www.superefficient.org/> (Last accessed 11th February, 2013)

Procurement: SEAD procurement activities aim to leverage the purchasing power of public- and private-sector buyers to draw highly efficient equipment and appliances into the market. These efforts are focused on developing effective policy instruments and advancing energy-efficient procurement practices. Some of the activities are development of a Street Lighting Evaluation Tool, a Procurement Best Practices Guide, and a Procurement Specification Catalog.

SEAD Technical Analysis: SEAD's cross-cutting Technical Analysis working group is undertaking a range of efforts to support SEAD activities – from the Superefficient.org portal, to development of a common analytical platform for assessing energy savings, to product-specific efficiency opportunity assessments. One of the technical analyses conducted by the group identified highly cost-effective opportunities to reduce television energy consumption by 25 percent or more with existing technology. It estimated that potential savings in SEAD economies can be as high as 8 TWh per year by 2020.

2 Super-Efficient Equipment Program (SEEP)

In this section we will describe the barriers for the market adoption of energy efficient appliances and how SEEP overcomes these barriers. We will also talk about the basic structure of the program and the benefits of such approach.

2.1 Barriers to market-adoption of energy efficient appliances

Energy efficient (EE) appliances use relatively less electricity and hence provide monetary benefits to the consumers. But, their market penetration remains quite low. There are several barriers to wide-spread market adoption of these appliances. First, the EE appliances are expensive than the inefficient ones. Consumers are very sensitive to the price of an appliance implying a very high discount rate. They tend to value cash today over future savings and hence they are reluctant to buy the expensive EE appliances even if they can pay for themselves and save money in future. In some countries, like India, consumers pay a lower, subsidized electricity tariff. This also brings down the benefits of EE appliances by increasing the amount of time it takes for EE appliances to pay for themselves. In some cases, electricity is supplied at no cost to consumers. For instance, nearly all farmers in India get free electricity and hence they have no incentive to invest more to buy an energy efficient pump.

Another reason is the lack of information on EE appliances. Consumers may not be aware of their availability in the market. They may not also have the information on the consumption of these appliances and the life-cycle analysis calculations which can demonstrate the cost- effectiveness of EE appliances. If the information is available, it may not be in a form which is easily understood by the consumer to enable him to make an informed decision.

Consumer uncertainty about the performance of a new product is also a common cause of reluctance to purchase an energy efficient appliance. Often, products that are new on the market suffer from lack of trust, limited product warranty or lack of credibility about a warranty.

Another importance reason is that of split-incentives. A builder may be inclined to adopt cheaper designs and appliances in the buildings to reduce the upfront costs since she is not going to be benefited from the improved efficiency. This leaves the consumers with no option but to use the inefficient appliances/designs provided by the builders.

All these barriers result in a low market demand for EE appliances. As a result, manufacturers are hesitant in introducing new EE appliances in the market. This un-availability of EE appliances further restricts their market penetration. Thus, the lack of consumer interest and the un-availability of efficient appliances reinforce each other to create low-efficiency equilibrium in the market.

2.2 Rationale for SEEP

As we saw in the last section, there are significant barriers that result in low market penetration of energy efficient appliances. The ultimate cost is paid by society as more and more power plants need to be built to meet the increased demand caused by the in-efficient appliances. A limited supply of the resources required for power generation such as land, fuel, and water and rising

concerns about the impacts of power generation on the global environment pose serious challenges to building new power plants. Hence, there is a strong case for government to intervene and implement policies and regulations to overcome the barriers facing energy efficiency.

One approach to overcome these barriers is Standards and Labeling (S&L). In this approach, standards set a minimum efficiency threshold for appliances while labels display information on the consumption and savings. The S&L approach helps in: (a) eliminating the very in-efficient models out of the market and (b) creating awareness among consumers. The S&L program has been successful in improving the efficiency levels of the market in many countries. However, there are limitations to the approach. First, the standards and labels are generally fixed at low levels of efficiency since they require consensus from all stakeholders including manufacturers to ensure their participation. Manufacturers are likely to oppose high levels of mandatory standards and labels. The high levels of standards may require advanced technology which may not be available with all the manufacturers. This results in standards and labels being significantly lower than the most efficient appliances based on existing technology and commercially available. We call these super-efficient appliances and equipment (SEE). For example, in India, the most efficient appliances available (5 star appliances) consume about 30-50% more electricity than the SEE commercially available in other countries. Secondly; the labeling approach aims to transform market by creating awareness among consumers which is a considerably slow process. Given the boom in sales of appliances, esp. in developing countries, the slow transformation means a significant loss of saving potential. Hence, it is imperative to look beyond S&L to achieve a significant technology leap-frogging at an accelerated pace.

The core idea of SEEP is to make super-efficient appliances and equipment (SEE) affordable by providing financial incentives to manufacturers to cover the incremental cost of production. The program is voluntary and will have multiple participants. The competition between the participating manufacturers will lead to the fans being aggressively priced in the market ensuring the passing of incentives to consumers. The reduction in price of SEE in market will in turn help to overcome the primary barrier of high upfront cost faced by the consumers. As the volumes of SEE build up, and the market starts transforming to SEE, the amount of incentive can be reduced and eventually discontinued. The program is meant to complement the S&L program. As the market transforms towards SEE, the standards and labels can be tightened accordingly. Thus, the S&L program will provide the floor for the efficiency of appliances and SEEP will raise the ceiling on the efficiency of appliances.

2.3 Features & Benefits of SEEP

There are several approaches to design incentive programs for energy efficient appliances. Figure 1 compares SEEP with other approaches based on two important features: (a) the geographic scope of the program and (2) the point of intervention for providing incentives. The horizontal axis shows the geographical scope of the program which increases from utility level to national level. This comparison may not apply to countries like South Africa where there is a single utility for the entire country. The vertical axis shows the point of intervention for providing incentives which goes upstream from customer to manufacturer. A program run by a utility limited to its service territory targeting incentives to consumer, in form of rebates, lies in the lower left corner of this graph, On

the other hand, SEEP lies in the upper right hand corner, because the scope is at the national level, and the incentive is provided upstream to the manufacturers.

There are several benefits of this approach:

Reduced transaction costs: In Figure 1, 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 various manufacturers. Similarly, the number of transactions decreases as the point of energy efficiency program intervention moves from customer to manufacturer. Thus the substantial reduction in transactions brings down the associated costs and also speeds up the process of approval, design and implementation of the program. Moreover, customer decision-making with respect to appliance purchases is driven by various factors such as the cost of the appliance, its utility value, usability, aesthetics (e.g. size, colour, form, etc.), brand value, and potential future energy savings. In contrast, the manufacturer’s decision-making process is entirely driven by only 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.

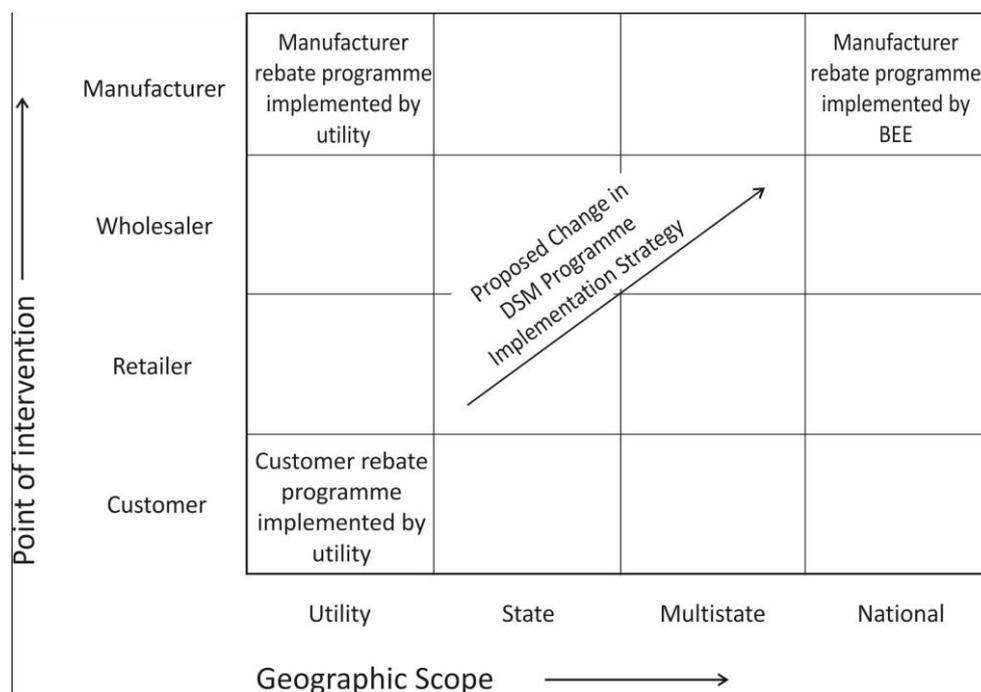


Figure 1: Comparison between SEEP and utility DSM

(Source: Adapted from the original figure developed by Ranjit Bharvirkar, Itron Consulting)

Reduced Burden on State Utilities and Regulators: SEEP is designed and implemented at a national level by a government agency entrusted with implementing energy efficiency policies in India. If each State Electricity Regulatory Commission (SERC) decides to initiate DSM in its respective state independently, its regulatory burden for developing regulations, issuing orders, assessing DSM program proposals, approving Monitoring and Verification (M&V) reports, and reviewing them would be substantial, particularly because these tasks will have to be performed repeatedly.

However, if a central government agency designs the DSM programs, implements them, and arranges for M&E, it will substantially reduce the burden on utilities and regulators.

Reduced Level of Incentive: Giving incentive upstream to manufacturers avoids wholesale and retail mark-ups and taxes. The rebates given to customers through utility DSM should cover these mark-ups and taxes and hence cost more. 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. The competitive bidding option also ensures the lowest level of incentive. Alternatively, if a negotiations approach is followed to determine the incentive level, a single entity will hold much greater bargaining power while negotiating with manufacturers owing to the larger market size at stake compared with each utility attempting to negotiate with manufacturers separately.

Reduced Complexity in Monitoring & Verification (M&V): In SEEP, the payment of incentives to manufacturers will be based on the number of efficient appliances produced and sold to consumers. This will be relatively easy to monitor using existing tax mechanisms like excise duty, central sales tax and value added tax as we discuss later. In contrast, for utility-administered programs, regulators often require to establish the causality for the energy efficiency savings. This requires tracking the SEE to the consumer level which needs more detailed evaluation carried out separately by each utility.

3 Background Analysis for SEEP

It is crucial to conduct preliminary analysis to answer questions that can be fundamental to SEEP: How much electricity can be saved from the market transformation to SEE? What is the potential cost effectiveness of SEEP? Which appliances should be selected for SEEP? Answering the questions requires significant data and analysis to project scenarios. In developing countries like India, data is scarce and often unreliable, and predictions are always fraught with high uncertainty. It is almost impossible to get accurate answers to these questions. However, certain high level, intelligent assumptions can be made to estimate the electricity savings that can be realized. In this section, we suggest a framework for this analysis. The analysis can be split into four components: The first component of the analysis can be to select those appliances that contribute significantly to the country's total electricity consumption. In the second component, the saving potential of the super-efficient models can be estimated for only those appliances identified in the first component. The third component estimates the costs and benefits of a SEEP like program that provides financial incentives to manufacturers. Finally, a priority analysis can be done based on a number of factors to prioritize the appliances among the selected ones for SEEP. The analyses are summarized in the following table.

Appliance consumption analysis	What is the contribution of major appliances to electricity consumption?
Saving potential analysis	What is the saving potential of super-efficient variants of top consuming appliances?
Cost-benefit analysis	What is the benefit to cost ratio of running a SEEP like program for top consuming appliances?
Priority analysis	How to choose the appliance for SEEP considering cost, total saving potential and other factors?

Table 1: Summary of Background Analysis

3.1 Appliance Consumption Analysis

The objective of this analysis is to identify the appliances that contribute significantly to the country's total electricity consumption. The electric appliances are mostly used in the residential and commercial sector. One approach to this analysis is to conduct extensive survey of households in the country specifically to obtain the above data. One such example is the Residential Energy Consumption Survey (RECS)⁴ in USA. Every four years, the Energy Information Administration (EIA) conducts RECS with a sample of occupants in single family homes, apartments and mobile homes across the United States. Trained interviewers meet with residents and record information on structural characteristics of the housing unit, energy consuming behavior, appliances and equipment. Following the household survey, EIA collects energy billing data for sampled households from their energy suppliers with a second survey. Complex statistical models allocate a household's total consumption to specific end-uses such as heating, cooling and refrigeration. This is a fairly rigorous approach and requires considerable resources and expertise which may not be available in

⁴Please refer <http://www.eia.gov/consumption/residential/> for more details (Last Accessed 15th February 2013).

developing countries. The alternative approach is to make certain high level, intelligent assumptions and use the available data to estimate a ballpark consumption share of appliances in the country's total electricity consumption.

We suggest a simpler approach that requires two data sets:

1. Appliance Stock Data
2. Appliance Unit Electricity Consumption (UEC) Data

3.1.1 Appliance Stock Data

There can be two approaches of estimating appliance stock data and either of them can be adopted depending on the available data. One way is to estimate the existing appliance stock data i.e. the number of appliances currently in use in the country and then estimate their electricity consumption. This approach requires inputs on ownership of appliances in households and commercial establishments as well as assumptions on consumption levels of appliance models depending upon their vintage. The other way is to estimate new appliance stock data i.e. the number of appliances being bought every year and then estimate their electricity consumption. This is a considerably simpler approach if the country-wide data on current sales of appliances and their consumption levels is available. The objective of appliance consumption analysis is to identify the major electricity consuming appliances and both the approaches can estimate the comparative consumption levels across the different appliance categories. We first describe the approach to estimate the existing appliance stock data.

The appliances are used in commercial and residential sectors. One possible source of data for the appliance ownership in the households can be the national socio-economic surveys that most of the governments conduct to study diverse areas like employment, consumer expenditure and literacy among others. For example, in India, the National Sample Survey Office (NSSO) conducts a survey of representative sample of households on consumption and expenditure on various goods and services⁵. The data from this survey can be used to estimate the penetration of appliances in Indian households.

There are few points that should be considered while estimating the appliance stock using this approach. The survey should have the data on number of units of a particular appliance category per household along with its ownership. For example, households may have only one refrigerator but 2-3 ceiling fans in their homes. In India, the NSSO survey asks the respondents only whether they own an appliance and not the number of units of that category. Estimating the stock based on this data can be inaccurate for some appliance categories like ceiling fans. In this case, other regional or local level surveys can be referred to estimate the average number of units per household. If there is no data available, an educated guess can be taken with consultation with experts. The experts can be asked to give a range of estimates which can help to do a sensitivity analysis.

Another point to be considered is that the surveys are typically conducted for households and have no data on the use of appliances in commercial and industrial establishments. The total stock in the country must account for these sectors. Some countries measure energy consumption for each

⁵ The survey data is publically available and can be obtained from the Ministry of Statistics and Program Implementation, Government of India. Please visit www.mospi.nic.in for more details about the surveys.

sector, for example, similarly to the RECS survey, the US conducts Commercial Buildings Energy Consumption Survey (CBECS)⁶ to collect information on the stock of U.S. commercial buildings, their energy-related building characteristics, and their energy consumption and expenditures. In absence of such extensive surveys, sector-wise share of current sales of appliances and their trends can be obtained either from market research reports or from manufacturing associations. An educated guess can then be made on the share of commercial and industrial sector in the total stock of appliances in the country.

When several house-holds surveys exist, it is highly recommended to compare results to get more refined estimates. The differences if any should be carefully examined and accounted for in the final data set. For example in India, data from a survey titled Indian Human Development Survey (IHDS)⁷ has been conducted by University of Maryland and National Council of Applied Economic Research (NCAER). The survey is a nationally representative multi-topic survey similar to the NSSO survey. These two surveys can be compared to conclude on the final data set for appliance ownership.

In order to estimate the new appliance stock data, we require the annual sales data of appliances. This can be obtained through market research reports if available. The sales data can also be obtained from industry associations or from the annual reports of individual companies. There is a possibility of variation in sales data from different sources especially in countries like India where there is a lack of centralized data. A comparative study of various data followed by consultation with industry experts is recommended. A sensitivity analysis estimating the range of variation can also help to quantify the effect of uncertainty on the total consumption.

3.1.2 Appliance Unit Energy Consumption (UEC) data

Unit Energy Consumption (UEC) is the average annual consumption of electricity by an appliance. It depends on two factors: (a) the power consumption of the appliance and (b) the usage pattern of the appliance. For example if a ceiling fan consumes 75W at the maximum speed, and a consumer uses the fan for about 6 hours a day for 6 months of the year, it will consume about 81 kWh of electricity. However, she may also use the fan at low speeds. The consumption of fan at low speeds can be accounted by using a correction factor for the total consumption at full speed. If we assume this factor as 0.8 (i.e. the total electricity consumed is 80% of the electricity consumed at maximum speed), then the approximate UEC of the ceiling fan will be about 65 kWh. It is quite complicated to estimate the UEC of the current stock. There are two important factors that need to be considered here: (a) the composition of the stock and (b) the variation in the end usage pattern across the country.

The composition of appliance stock for a particular appliance category can be heterogeneous.. For every appliance category, models come in different sizes and types. For example, in case of refrigerators, there are two important types; Direct Cool (DC) and Frost Free (FF). Refrigerators come in all sizes varying from 150 liters to 500 liters. The type and size of refrigerators significantly affect its UEC. Even for a typical size and type, the power consumption of the model can vary according to the technology used. A highly efficient model can consume much less electricity as compared to an in-efficient cheap model. Additionally, in case of existing stock, it consists of models of different

⁶ Refer <http://www.eia.gov/consumption/commercial/> for details (Last Accessed 15th February 2013)

⁷ Refer <http://ihds.umd.edu/> for details (Last Accessed: 15th February, 2013)

vintages. Some models may be 10 years old while some may have been bought last year. There can be a substantial difference in the power consumption of such models. We have to know the composition of the appliance stock according to its vintage, size and type to estimate the representative average UEC.

The second factor that determines UEC is the appliance usage pattern across the country. The usage pattern in a region is generally a result of the standard of living, culture and the local climate. For example, a region with high standards of living and hot and humid condition may use air-conditioners (AC) for 24 hours a day as compared to the region with pleasant weather conditions where ACs will be used for much less time. As mentioned in the introductory paragraph, the usage pattern not only involves the number of hours the appliance is used but also the control settings at which it is used. For example, an AC set to temperature at 18 degree Celsius will consumer much more energy than the AC set to temperature of 24 degree Celsius. It is important to know all these aspects of the usage pattern of the consumers across the country to estimate accurate UEC.

As can be seen from the number of factors affecting UEC, it is very complicated to estimate the average representative UEC for an appliance category. This gets further difficult given the data constraints in developing countries and requires surveys on usage patterns. Hence, we have to resort to high level intelligent assumption as in the case of appliance stock data.

The issue of the composition of the stock for a particular appliance category may be addressed by identifying most popular models available in the market today based on type and size. This can be done through a preliminary internet-based market survey of shopping websites or using the data from market research reports. For example, in India, direct cool refrigerators comprised about 75% of the sales in 2010-11, 91% of which were in 165-226 liter category⁸. Thus, for the present analysis, the entire refrigerator market in India can be classified into two categories: direct cool and frost free. A typical model of 180 liters can be assumed for direct cool segment and a 250 liter model for frost free segment. Both will have different UEC. In case of existing stock, the past sales trends should be identified in order to apply this composition to the stock. For instance, the frost free refrigerators have gained a significant market share only recently which was dominated by the direct cool refrigerators. Hence, it can be assumed that most of the current stock may be the direct cool refrigerators. Similar assumptions can also be made for efficiency improvement over the years. In India, the market for ceiling fans has remained stagnant for almost last 10-15 years. The ceiling fan with a 1200 mm sweep which consumes 75W of electricity has been the product with almost 70-80% of market share. Same cannot be said about other products like refrigerators or televisions. Assumptions should be made for these appliances after consulting with industry experts.

The issue of varying end-usage pattern across the country is more complicated to address. There may be small regional level surveys done by researchers which estimate consumption pattern of the region⁹. However, as we have seen they cannot be assumed to be representative of the whole country. In the absence of a national level survey, it is difficult to estimate a representative usage pattern of the appliance. One way to address this is to refer to the regional level usage patterns and

⁸TV Veopar Journal, April-2012, ADI media publication. Available on: http://www.adi-media.com/PDF/TVJ/annual_issue/009-Refrigerators.pdf (Last Accessed: 15th February, 2013)

⁹ For example, refer Murthy, N. K.V., Sumithra, G. D. & Reddy A. K. N..(2001). End-uses of electricity in households of Karnataka state, India.*Energy for Sustainable Development*, Vol. V, No 3, page 81-94.

approximate the patterns for national level standard patterns consulting the experts in the area. We also have to make approximations for the different settings used for the appliance. For example, in the case of ceiling fans, it may be used at maximum speed as well as low speed.

3.1.3 Estimation of Total Electricity Consumption by Appliances

Equipped with the data on appliance stock and the estimate of average UEC, the total electricity consumption by a particular appliance category can be computed. For example, if there are 5 million air-conditioners in a country with an average UEC of 1200 kWh/year, then the total electricity consumption by the air-conditioners will be 6 billion units of electricity. This will account for all the major types and sizes available in the market.

It has to be noted that the suggested approaches to address the variability in the composition of the existing as well as new stock and the end-usage pattern lead to approximate estimates. As has been mentioned repeatedly, given the data constraints in developing countries we have to make such assumptions. It is highly recommended to compare the results of the analysis with macro level data if available. For example, in India, Central Electricity Authority (CEA) releases total electricity consumption in the country with the sector-wise share of industry, residential, commercial and others¹⁰. We can add the total electricity consumptions of all the household appliances estimated by our approach to calculate the total annual residential consumption from the existing stock. It should be comparable to the macro-level data published by the government. If there is a large level of uncertainty in the available data, then a sensitivity analysis can be conducted to identify the confidence level of the analysis.

Box C : Appliance Consumption Analysis Example

Boegle et al¹¹ analyzed the appliance consumption in India for 17 major appliances for the year 2008. They used the surveys conducted by National Sample Survey Office (NSSO) in 2005 to estimate the stock for that year. They estimated the stock in 2008 using various assumptions for sales and replacement for the old stock.

The appliance stock data and UEC from the analysis are shown in Table 2. The total consumption in all households of almost 152 TWh in Table 2 is reasonably close to the total of 148 TWh estimated by CEA¹² for 2008 providing validity for the methodology used and the calculations made by the authors.

shows the share of the total consumption of top nine appliances. It is interesting that just four appliances/end-uses– lighting (incandescent bulbs and tube lights), fans, refrigerators and televisions– contributed 80% of the total household consumption in India in 2008 ..
.....Contd

¹⁰ Refer Central Electricity Authority (CEA). (2010). All India Energy Statistics (2008-2009). General Review 2010. Government of India, Ministry of Power, New Delhi, India.

¹¹Boegle, A., Singh, D., & Sant, G. (2010). *Targeting Energy Efficiency Efforts - Saving Potential from Indian Households from Improved Efficiency*. Prayas Energy Group. Available on: <http://www.prayasenergy.org/peg/publications/item/82.html>(Last Accessed: 15th February, 2013)

¹²Central Electricity Authority.(2009). *All India Electricity Statistics, General Review*. Government of India, Ministry of Power.

Type of appliance	Stock (million)	Unit Energy Consumption (UEC) (kWh/year)	Total (TWh)
Fan	246	112	27.60
Incandescent bulb	302	80	24.22
Refrigerator	37	588	21.95
Television (TV)	99	175	17.27
Tube light	280	107	30.08
Air conditioner	5	1199	6.05
Room heater	9	555	5.00
Electric Water heating (Geyser)	10	438	4.58
Air cooler	19	195	3.70
Stand-by-power		3.06	
Washing machine	15	185	2.77
Radio	60	33	1.96
Compact Fluorescent Lamp (CFL)	68	22	1.49
Tape recorder, CD player	37	34	1.24
Computer	6	105	0.60
Set-Top Box	11	22	0.24
DVD Players	29	1	0.03
VCR VCP	3	2	0.01
Total		151.86	

Table 2: Appliance Stock Data and UEC

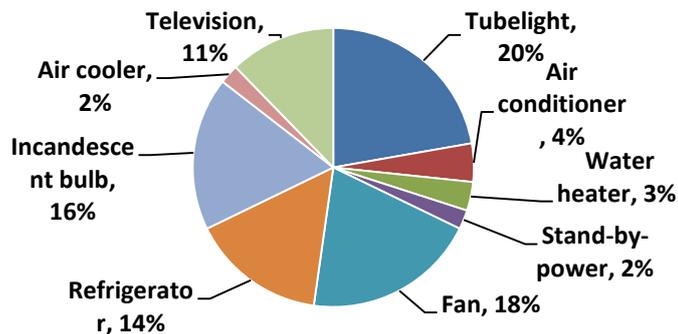


Figure 2: Major appliances consumption share in India in 2008

3.2 Saving Potential Analysis for Selected Super-Efficient Appliances

The objective of this analysis is to estimate the savings in electricity that can be realized in a near future from the market transformation to super-efficient models of selected appliances. The appliances selected are those that contribute significantly to the country's total electricity consumption as evident from our appliance consumption analysis. We suggest a simple approach towards this analysis that includes following steps:

1. Predict the trend in the sales of the appliances for the analysis period.
2. Construct a baseline scenario to predict total electricity consumption from the sold appliances in the analysis period, where the efficiency of these appliances is determined by market and existing energy efficiency policies of the government.

3. Analyze super-efficient appliances available in international markets and identify an appliance that fits the local requirements.
4. Construct a super-efficient scenario to predict total electricity consumption from the sold appliances in the analysis period, where efficiency levels are decided by a program like SEEP that achieves market transformation to super-efficient appliances.
5. Estimate the saving in electricity that can be achieved through SEEP as a difference in electricity consumption of baseline scenario and super-efficient scenario.

We explore each step in this analysis in detail in following sections.

3.2.1 Appliance Sales Predictions

Appliance sales predictions involve predicting the pattern of appliance sales in the analysis period. The number of appliances sold determines the quantum of electricity savings. There are two approaches to predict the sales pattern.

The first approach involves predicting appliance ownership using a bottom-up approach. The appliance ownership of future can then determine the sales of appliances. In this analysis, the appliance ownership of a household is determined by its monthly income. A good proxy for the monthly income can be the household monthly expenditure which is usually recorded in most national socio-economic surveys. A Gompertz¹³ function can be used to link the appliance ownership to the monthly household expenditure. The household expenditure is further linked to the Gross Development Product (GDP) of the country. Thus, by predicting the GDP growth, we can estimate the monthly household expenditure and consequently the appliance ownership. Letschert and McNeil¹⁴ have conducted one such analysis for India. This approach is useful to predict appliance ownership (and hence sales) for long term such as 2030. SEAD initiative has built a common analytical platform to assess savings from energy efficient appliances for different countries. This platform is based on Lawrence Berkeley National Laboratory (LBNL)'s Bottom-Up Energy Analysis System (BUENAS) model¹⁵. An alternative approach is much simpler and suitable if the prediction is required for the near future.

A number of market research reports predict sales for next 5 years based on the data from industry and other macro-economic assumptions. These predictions can be extended to continue over the analysis period. The penetration of appliances in the households of developing countries is normally low. Some of the households do not have access to electricity. Hence, constant growth can be assumed in sales of the appliances. The sales growth can be assumed to be on a conservative side to account for the constant growth assumption. Higher the sales, more is the potential of saving electricity through super-efficient appliances. Hence, a conservative estimate of sales will give a guaranteed savings quantum. If the actual sales increase, the savings will be much higher. The sales

¹³ It is type of a mathematical model for time series where growth is slowest at the start and end of a time period. http://en.wikipedia.org/wiki/Gompertz_function (Last Accessed 15th February 2013)

¹⁴ Letschert, V., & McNeil, M. (2007). *Coping with Residential Electricity Demand in India's Future- How Much Can Efficiency Achieve*. Lawrence Berkeley National Laboratory, LBNL-63199.

¹⁵ Refer <http://superefficient.org/Products/BUENAS.aspx> for more details (Last accessed 15th February, 2013)

growth rate can be identified by comparing several market research reports and talking to industry experts.

3.2.2 Baseline Scenario Electricity Consumption

In this section, we describe the baseline scenario to estimate the savings in electricity from the market transformation to super-efficient appliances. It predicts the electricity consumption that will occur due to the appliances that will be sold in the absence of SEEP like program. The crucial question to answer here is: which appliance will a consumer buy if SEEP is not implemented? Will she buy an efficient appliance already available in the market today or a very cheap, in-efficient appliance? The analysis also requires the prediction of the efficiency levels of the appliances available in the market in the future if SEEP is not implemented.

The first step is to identify the base year. This can be the year when the SEEP is going to be launched. The sales data of the year previous to the base year can be analyzed. Different models with different levels of efficiency would have been sold for the most popular size and type in a particular appliance category. From the sales data, the sales-weighted efficiency level of the models available in the market can be calculated. If precise data on sales of individual models is not available, the sales data available from the energy rating bands can be used. For example, in India, the Bureau of Energy Efficiency procures the data from manufacturers on the number of models sold in a particular energy rating band. By assuming an average efficiency level of the band, the weighted efficiency level of the models available in the market today can be calculated.

This efficiency level of an appliance will improve as the technology improves. The market will force manufacturers to adopt new technologies to reduce energy consumption. The efficiency levels can also be affected by government programs. Government can announce mandatory minimum performance standards which will push the efficiency levels of the appliances. However, as we have already seen in section [2.2](#), these efficiency levels set through MEPS are considerably less than the efficiency levels of SEE. These factors should be considered while predicting the future efficiency levels in the baseline scenario. Since there is a high level of uncertainty involved in this prediction, it is suggested to do a sensitivity analysis by assuming multiple scenarios of different levels of improvement. One scenario can assume an aggressive improvement in efficiency where a stringent S&L is implemented while another scenario can assume a moderate improvement in efficiency where a less stringent S&L is implemented.

Once the weighted efficiency level and its trend are identified, the sales data can be used to predict the baseline electricity consumption from the appliance. Since our interest is in estimating the saving potential, we can only focus on new sales and not the stock. If the analysis period is longer than the product life of the appliance, then it may be assumed that all the appliances bought in the baseline year will be present at the end of the analysis period. If the analysis period is shorter than the product life of the appliances, a replacement function should be considered in which some of the appliances bought in the baseline year will be replaced by new appliances. An example of a replacement function can be found in McNeil et al¹⁶.

¹⁶McNeil, M., Iyer, M., Meyers, S., Letschert, V., & McMohan, J. (2008). Potential Benefits from Improved Energy Efficiency of Key Electrical Products: The Case of India. *Energy Policy* (36), 36 3467-3476, 3467-3476.

3.2.3 Identification of Super-Efficient Appliances

The next step is to identify super-efficient appliances that are commercially available in the international markets. The primary rule for selecting the super-efficient appliances is that the technology should be available in the commercial market. As the primary goal of SEEP is the rapid deployment of existing technology, a conceptual level technology should not be chosen. We should also remember that at this stage, we need only a preliminary analysis for selected appliance categories. A detailed techno-economic analysis should be conducted at the subsequent program design stage for a particular appliance category. At that stage, manufacturers will also be involved in the discussion to understand the feasibility of such technology. At this point, the focus should be on getting a fair idea of the potential improvement that can be possible in an appliance category. The information on super-efficient appliances can come from different sources. One of the sources is the technical reports published through the SEAD initiative. For example Lawrence Berkeley National Laboratory (LBNL) has published a report on energy consumption trends and energy efficiency improvement options of televisions¹⁷. Another source to get information on super-efficient appliance can be the top-ten info websites¹⁸. These country/region specific websites list the top ten energy efficient appliances available in that country or region. Currently, the websites are available in USA, European Union and China.

There are two points that should be considered before identifying the super-efficient model in an appliance category. The super-efficient model selected must cater to the local needs. The type and size of the models must be comparable to those popular in the country. For example, the refrigerators in the USA are mostly above 400 liters while in India the most popular type refrigerators sold are in the range of 180-250 liters. So a super-efficient refrigerator model from USA cannot be a good reference point for India. One has to select a comparable model. The appliance use should also be considered. For example, in USA ceiling fans are used as a decorative item or to circulate air in an air-conditioned room. Hence the speed requirement for these ceiling fans is very low and hence they consume less energy. However in India, a ceiling fan is used to provide relief from its tropical hot conditions. Hence the speed requirement is high as compared to the ceiling fan in USA. Hence we cannot identify the most efficient ceiling fan in USA as a super-efficient model for India.

The second point to consider is the different methodologies that different countries use to measure energy efficiency of an appliance. For example, a refrigerator sold in the European Union with a declared consumption of 300 kWh/year may not be more efficient than a similar refrigerator consuming 400 kWh/year in India. This is because the ambient conditions specified for testing in EU are lower as compared to India. The warmer ambient conditions in India require more energy consumption to maintain the internal temperature of refrigerator. In order to address this situation, a normalization method should be applied so that the energy efficiency metrics are comparable across different countries. A good resource for the normalization exercise is the 4E Mapping and

¹⁷ Won Young Park, Amol Phadke, Nihar Shah, Virginia Letschert, TV Energy Consumption Trends and Energy-Efficiency Improvement Options, Lawrence Berkeley National Laboratories. Available on: <http://www.superefficient.org/en/Resources/Product%20Technical%20Analyses.aspx> (Last accessed: 15th February, 2013)

¹⁸ <http://www.topten.info/> (Last Accessed: 15th February, 2013)

Benchmarking website¹⁹. It is an inter-country collaborative project co-ordinated by International Energy Agency (IEA) to help policymakers understand differences in product performance and energy consumption between countries. See [Box D](#) for an example of how testing methodologies differ for refrigerators across countries and how the declared energy consumption values can be normalized.

Box D : Energy Efficiency Metrics Normalization Example

The energy efficiency of a refrigerator is measured by its annual electricity consumption. The standard method to compute the annual electricity consumption is to place a refrigerator in a testing chamber and measure its electricity consumption for a day. This daily consumption is then multiplied by 365 to get the annual consumption. There are a number of points that differ across countries in this methodology. Among other things, a significant difference that affects calculated energy consumption is the specification of temperatures for testing chamber and the internal compartments of the refrigerator. For example, the testing methodology in India specifies an ambient temperature requirement of 32 degree Celsius while in the European Union it is 25 degree Celsius. A same refrigerator will consume more electricity if the consumption is measured using the Indian method since it has to perform more cooling as the ambient temperature requirement is high. In order to compare the declared annual electricity consumption values across countries they should be normalized with respect to a benchmark value. A rigorous analysis is required to identify the normalization factors. In case of refrigerators, IEA co-ordinated 4E Mapping and Benchmarking project has devised a normalization method. Details can be found in their report²⁰. Figure 3 shows the comparison of annual energy consumption levels of the highest energy efficiency rating in four countries, India, China, EU, and USA using the above normalization method and Indian method as a benchmark. The refrigerator chosen is a 250 liter frost free type-refrigerator. A substantial change can be seen between the declared values and normalized, comparable values.

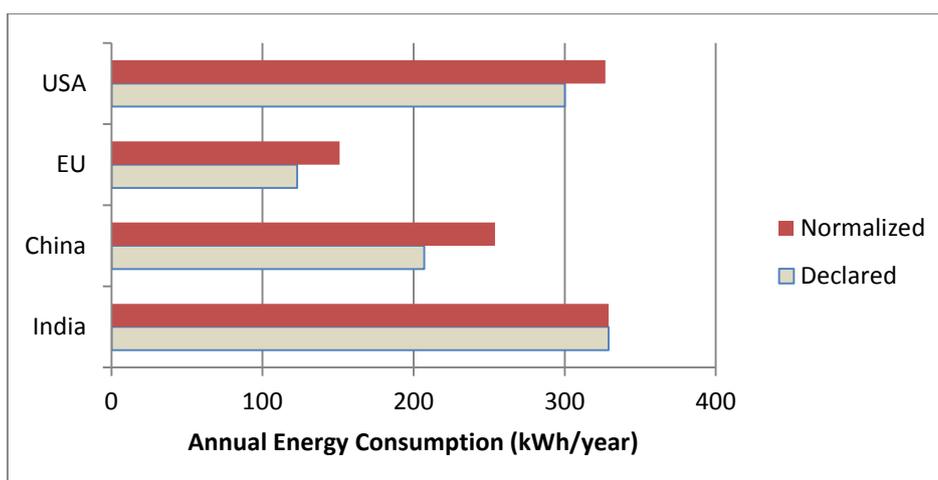


Figure 3: Methodology Comparison for Refrigerator across countries

¹⁹ <http://mappingandbenchmarking.iea-4e.org/> (Last Accessed: 15th February, 2013)

²⁰ Available on: http://mappingandbenchmarking.iea-4e.org/shared_files/162/download (Last Accessed: 15th February, 2013)

3.2.4 Super-Efficient Scenario Electricity Consumption

After identifying the super-efficient appliances and their consumption levels, the next step is to construct a scenario where the market is transformed to these appliances. The primary assumption for constructing this scenario is the level and rate of penetration of super-efficient appliances that can be achieved through SEEP. An aggressive implementation of SEEP can achieve high levels of penetration at rapid rates while a moderate SEEP will achieve otherwise. It is recommended to do a sensitivity analysis by constructing different scenarios as done in the baseline scenario. Once the levels and rate of penetration are decided, the rate of improvement in the super-efficient technology over the analysis period has to be identified. The rate of improvement will generally be slower than the one assumed for natural improvement in technology in baseline scenario as the super-efficient technology is quite advanced to start with. It is also advised to take conservative estimates wherever the trends are not known as this will enable to estimate a minimum guaranteed savings from the program. The next step is to use the sales data to predict the electricity consumption from the new sales. This is again similar to the baseline scenario analysis.

3.2.5 Saving Potential Estimation from Super-Efficient Appliances

The energy saving can be calculated as the difference between the total electricity consumption in the baseline scenario and the super-efficient scenario. The saving can be calculated annually. This is called the deemed savings approach. For any particular year, energy will be saved from the super-efficient appliances sold in that year as well as in the years before that for the estimated life of the product. For example, the energy saving in the year 2015 will be from the super-efficient appliances sold in 2015 as well as those sold in 2014 and 2013, if SEEP was launched in 2013. The energy savings can be represented as the total annual energy savings in the final year of the analysis period. It has to be noted, that this analysis does not cover the total benefits of the appliances sold in the analysis period. For example, the super-efficient appliances sold in the final year of the analysis will save energy over its product life. These benefits can be estimated as well. We can also quantify other benefits from SEEP such as avoided peak capacity and green-house gas (GHG) emissions. [Box E](#) explains the method to estimate avoided peak capacity. The avoided GHG emissions can be easily estimated using the emissions factor of the electricity sector. The urgency of the program can be highlighted by estimating the amount of energy savings that are being lost by delaying the program by only one year. This can be shown by calculating the energy savings from an appliance over the product life. For example, if a refrigerator saves 100 kWh/year and it runs for 10 years, it will save 1000 kWh/year over its life. So, if a million refrigerators are sold per year, an opportunity of saving 1 billion units per year is lost if the program is delayed by a year.

Box E : Avoided Peak Capacity Calculation

The electricity saved by the super-efficient appliances will cut the peak demand and hence can avoid the building of capacity to meet the peak demand. In order to calculate the peak capacity avoided, we should know the peak coincidence factor of the appliances. The peak coincidence factor is the percentage of the total stock of an appliance category that is in use during the peak load time. If there is no data available on peak coincidence factor, an intelligent guess based on consultation with experts will suffice. The avoided peak capacity can then be calculated using the following formula:

$$\text{Avoided Peak Capacity (MW)} = \frac{E_{\text{saved}} * PCF}{(1 - T\&D) * H * A}$$

Where

E_{saved} = Annual Energy Saved from the super-efficient appliances (MWh/year)

PCF = Peak Coincidence Factor (%)

T&D = Transmission and Distribution Losses (%)

H = Annual hours of usage of the appliance category (hours/year)

A = Availability of power plants (%)

The avoided peak capacity can be calculated for the last year of the analysis period as all the super-efficient appliances sold in the analysis period will be in use. T&D losses and Availability of power plants are the standard parameters in power sector and are generally known. The availability of power plant can be assumed for a typical plant prevalent in the country. It can also be the type of power plant which is likely to be avoided by the energy savings.

Box F : Saving Potential Analysis Example

Chunekar et al²¹ estimated the savings that can be achieved in India from market transformation to super-efficient models of four appliances namely ceiling fan, televisions, refrigerators and room air conditioners. The analysis period is from 2010 to 2020. The baseline scenario includes the impact of Standards and Labeling (S&L) program run by Bureau of Energy Efficiency (BEE), the nodal agency to implement energy efficiency and conservation policies and programs in India. Two possible scenarios of the impact of S&L program were evaluated: moderate and aggressive implementation of the program. The super-efficient appliances were chosen based on the type and size popular in India.

Appliance	Unit	Efficiency level of a 5-star rated appliance in 2010	Efficiency level of an SEA ¹ in 2010	Decrease in UEC ² (%)	Technology assumed for SEA
Room air conditioners	EER ³	3.1	4.86	36	The most efficient grade 1 AC (1.5 T capacity) in China (Source: Top 10 China, 2010)
Frost-free (FF) refrigerators	kWh / year	411	128	69	The most efficient grade 1 215-litre FF refrigerator in China (Source: Top 10 China, 2010)
Television sets	W	62	36	41	A 32" LCD TV set in USA with LED back-lighting and auto brightness control (Source: Top 10 US, 2010)
Ceiling fans	W	51	35	32	A brushless direct-current (BLDC) motor

¹super efficient appliances, ²unit energy consumption, kWh/year, ³energy efficiency ratio

Table 3: Technologies and efficiency levels of super-efficient appliances

A rapid market transformation was assumed to estimate the maximum savings possible from a program called Super-Efficient Appliances Program (SEAP). The program is same as SEEP but was named differently in the report. Sensitivity analysis was also carried out to estimate the variation in savings if the rate and level of market penetration is lowered. Results are shown in following charts and tables. Table 3 lists the super-efficient technologies for the four appliance categories. Figure 4 shows the annual total electricity consumption in 2020 in all the three scenarios. Table 4 shows the summary of the savings achieved from a Contd

²¹Chunekar A, Kadav K, Singh D and Sant G, *Potential Savings from Key Super-Efficient Electrical Appliances in India*. Prayas Energy Group, 2011. Available on: <http://www.prayasenergy.org/peg/publications/item/155.html> (Last Accessed: 15th February, 2013)

...SEEP program as compared to the moderate and aggressive scenarios of implementation of S&L. Figure 5 shows the results of the sensitivity analysis. The scenarios SEAP 90, SEAP 60 and SEAP 30 correspond to the situations where 90%, 60% and 30% of the total appliance sold in the period 2010-2020 are super-efficient appliances. It can be seen that even a 30% penetration of SEA can result in savings more than the scenario where S&L program is implemented aggressively.

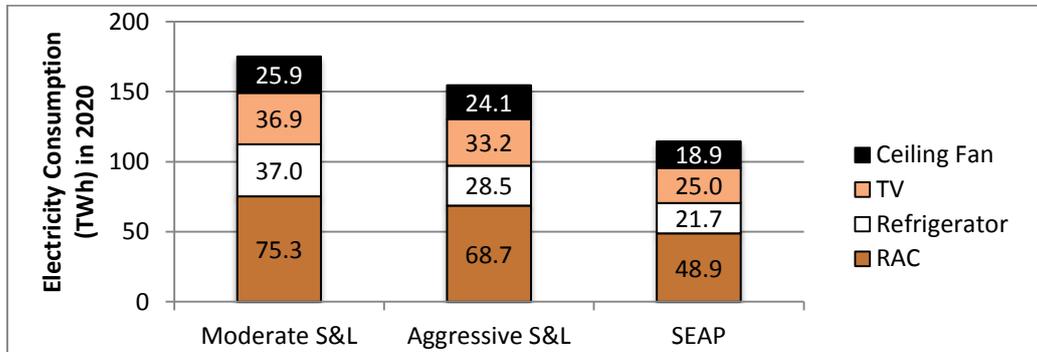


Figure 4: Annual electricity consumption from four appliances in India in 2020

Scenario	Annual savings (TWh) 2020	Avoided peak capacity in 2020 (MW)	Avoided emissions in 2020 (million tonnes of CO ₂)
Aggressive standards and labeling (S&L)	20.6	7,023	16.7
Super-efficient appliances program (SEAP)	60.7	21,620	47.9
SEAP over Aggressive S&L	40.1	14,597	31.7

Table 4: Summary of Savings in India

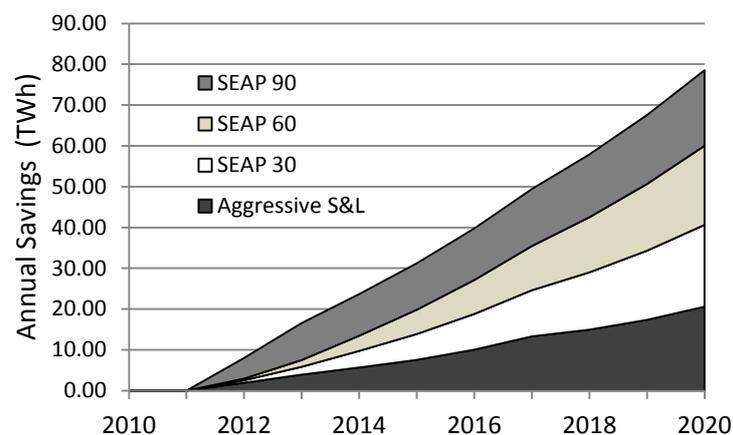


Figure 5: Sensitivity Analysis of savings in India in 2020

3.3 Cost Benefit Analysis

The objective of the analysis is to estimate the costs and benefits of a program like SEEP. The first step in this analysis is to estimate the incremental cost of producing a super-efficient appliance over a normal appliance. The incremental cost can be estimated through a techno-economic analysis of all the energy efficiency options available. This analysis yields cost efficiency curves that plot the efficiency options against the incremental costs. An optimized combination to all the options available can be done to finalize a super-efficient option. The conditions mentioned in section [3.2.3](#) should also be considered while finalizing the option. The techno-economic analysis should also consider the economies of scale while estimating the incremental cost. ICF international did such a techno-economic analysis²² for refrigerators in India. The incremental cost can then be used to estimate the cost-effectiveness.

The cost effectiveness of any energy efficiency measure can be assessed by comparing the cost of conserved energy (CCE) with the cost of the electricity that is saved by the measure. The cost of conserved energy is calculated by annualizing the cost of the measure over its life, and dividing the annual cost by the annual energy saved, which will give the CCE in Rs/kWh (see [Box G](#)). In case of a super-efficient appliance, the incremental cost of its production can be annualized as mentioned above. An energy efficiency measure is cost-effective as long as the CCE is less than the cost of generation of electricity. This is the case for most of the energy efficiency measures. If we have only preliminary estimates of the cost, we can do a sensitivity analysis to calculate the CCE for a band of possible incremental costs.

The next step after assessing the cost effectiveness is the monetization of the benefits of SEEP to estimate the cost to benefit ratio. The first benefit is the saving in fuel due to the electricity saved. This can be computed by making assumptions on the type of the fuel and its cost for generating electricity in the country. The second benefit is through the capital expenditure saved on the avoided capacity. This can be computed by assuming a typical cost of building a power plant in the country. These are the two major monetary benefits. Other benefits like avoided greenhouse gas (GHG) emissions can also be monetized based on the price of carbon. The program frees up capital that can be used for some other purpose. This contributes to increasing the GDP of the country. We can use the Incremental Capital Output Ratio (ICOR) to estimate the impact on GDP. Examples of measurement of benefits can be found in Singh et al²³ and Singh & Sant²⁴.

²² ICF International, *Techno-Economic Analyses of the Incremental Cost of Super Efficiency for Refrigerators in India*, July 2012.

²³ Singh G, Sant G, Chunekar A, Pednekar A and Dixit S, *Development of Super-Efficient Equipment Program (SEEP) for fans*, Prayas Energy Group. Available on: <http://www.prayasenergy.org/peg/publications/item/175.html>

²⁴ Singh D and Sant G, *Rationale for Financial Incentives for Energy Efficiency*, Prayas Energy Group.

Box G : Cost of Conserved Energy (CCE)

The CCE of any energy efficiency measure can be calculated by annualizing the cost of the measure over its life and dividing the annual cost by the annual energy saved. Let's consider an example of a ceiling fan. Consider a super-efficient ceiling fan that consumes 35W as compared to an in-efficient fan that consumes 70W. The super-efficient fan costs Rs. 300 more than the in-efficient fan. The life of both the ceiling fans is 15 years. What is the CCE of the super-efficient fan?

The most important assumption in the estimation of CCE is the discount rate. Discount rate is an indicator of the valuation of future benefits from the current investment. It is pretty high in case of individual consumers, since they highly value the cash in hand rather than the benefits in future. However, the discount rates are quite lower from the point of view of a government or even a utility. In most of the cases it can be assumed to be 10-12%. Refer Howarth and Sanstad²⁵ for more on discount rates and their use in energy efficiency.

Going back to the example of the super-efficient ceiling fan, assuming a discount rate of 10%, we get the annualized incremental cost²⁶ as Rs. 39. The annual savings can be computed as 50.4 kWh²⁷. These savings are at the consumer's end. However, we should also consider the transmission and distribution (T&D) losses to estimate the savings in the electricity generation. Assuming T&D losses of 20%, the annual saving of electricity at bus-bar is 63 kWh/year. The CCE can then be calculated by dividing the annualized cost by annual savings which comes out to be Rs. 0.63/kWh. The approximate cost of generation in India is about Rs. 2.3/kWh. Hence, it can be seen that the super-efficient ceiling fan is very cost-effective.

3.4 Priority Analysis

The objective of this analysis is to prioritize the appliances among the selected ones that can be the first choice for the launch of SEEP. The first-cut selection of appliances was based on their contribution to the total residential and commercial electricity consumption. However, it is not advisable to run the program for all the appliances. A better idea will be run the program for one or two appliances in the beginning and then extend it to other appliances.

The primary criterion for selecting the appliances is the cost of conserved energy (CCE). The CCE has to be lower than the cost of generation and supply of electricity to make the program economically sensible. Among the selected appliances, the obvious choice will be the one with the lowest CCE. However, the CCE criterion should be considered along with the total saving potential impact of an appliance category. An appliance may have the lowest CCE, but if the total saving potential of the appliance is low, due to low sales, then it may not be worth conducting the program for the

²⁵Howarth, B., & Sanstad, H. (1995). Discount Rates and Energy Efficiency. *Contemporary Economic Policy*, 13(3), 101–109. doi:10.1111/j.1465-7287.1995.tb00726.x

²⁶This can be calculated using a function in the software MS Excel. The syntax for this function is PMT (rate, nper, pv), where in this case, rate is the discount rate, nper is the life of the ceiling fan and pv is the incremental cost

²⁷Assuming 1800 hours of usage and 0.8 as a factor to account for speed variation.

appliance. Hence the appliance selection should have low CCE and high saving potential impact. It has to be noted that the saving potential is not necessarily related to the total consumption. The total consumption of electricity by an appliance category may be high but it may have low saving potential and vice versa.

Another important criterion is the political acceptability of the program for an appliance category. The political acceptability of the program will be high for mass appliances like ceiling fan and TV as compared to luxury items like air-conditioners. For example, in India where one-third of households have no access to electricity, a program that provides incentives to super-efficient air-conditioners have low chances of political acceptability even if the program has high saving potential.

Another criterion to be considered is the rebound effect. Increased efficiency can lower the operating cost of an appliance which may in turn lead to increased use of that appliance. This can reduce the savings that can be achieved through efficiency. Such effect is called rebound. For example, a consumer who uses air-conditioner only for four hours in afternoon can afford to use it more if the operating cost goes down because of efficiency. The rebound effect has been found to be as high as 30% in case of space heating and cooling²⁸. In other appliances like refrigerator, television or ceiling fans such effect is found to be negligible.

We also have to consider the nature of the appliance market in the country. A consolidated market with few manufacturers is generally favorable for SEEP. This facilitates quick and easy negotiation with manufacturers for super-efficiency levels. It also makes monitoring and verification of the program easier. The presence of global companies is also favorable since they have access to technology and can introduce their super-efficient appliances from international markets to the local markets. However, at the same time an appliance category should not be rejected based on a fragmented market with a number of local manufacturers. The program can be specifically designed to address such situations.

Another criterion to consider is the technology fluidity in the appliance category. There may be rapid development of technology leading to better energy efficiency in one category while the technology may be completely stagnant in other category. For example, in case of televisions, technology is rapidly developing with more and more efficient Liquid Crystal Display (LCD) televisions replacing the traditional Cathode Ray Tube (CRT) televisions. In televisions, the technology that improves the efficiency also results in the better quality of the product. This justifies the market-driven technology development. However in case of ceiling fans, where energy use is not related to the performance of the product, the technology is almost stagnant. SEEP should be directed more towards the appliance categories which are almost stagnant. Programs like these can spur innovation and bring about efficient appliances.

There is no straightforward weight assignment to the different criteria described above which can enable the choice of the appliances that would be selected for SEEP. Different countries may have different priorities leading to different choices of appliances.

²⁸Sorrel, S. (2007). *The Rebound Effect: an assessment of the evidence for economy-wide energy savings from improved energy efficiency*. UKERC.

4 Program Design and Implementation

The objective of this section is to describe various aspects related to program design and implementation. There are some basic principles that should guide the program design. First, the program should be simple and easy to administer. A complex program with bureaucratic hassles will keep the manufacturers away. At the same time, the program should provide adequate checks and balances since it involves providing financial incentives to manufacturers. It will also be beneficial to involve all the stakeholders including manufacturers in the process of program design. Finally, transparency in decision-making is crucial to ensure accountability. Every decision making process should be well documented. The steps in the program design and implementation and the relevant questions that should be answered at every step are summarized in Table 5. In the following subsections we will describe in detail the various steps.

4.1 Funding

There may be three potential sources of funding for SEEP: (a) central government (b) Utilities and (c) International Climate Finance. The two key criteria for assessing these alternatives are: (1) sustainability of the funding and (2) transaction costs involved in securing the funding.

4.1.1 Central Government Funding

The main advantage of obtaining funding for the program from central government is that only one entity and a small set of decision-makers need to be convinced of the benefits of this effort – i.e. smaller transaction costs. 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. For example, investing in energy efficiency 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 central government budget is that it may not be sustainable as it would be subject to political change and also compete with other government funding priorities like education, health, defense and others.

Steps	Questions
Funding	<ul style="list-style-type: none"> • What will be the source of funding: federal government, utility or international finance?
Technical specifications	<ul style="list-style-type: none"> • What should be the specifications for energy consumption and performance of SEE and how to identify them?
Incentive Determination mechanism	<ul style="list-style-type: none"> • How to determine incentives: bidding, uniform incentive or mixed approach?
Incentive criteria	<ul style="list-style-type: none"> • Who should participate in the program? • What should be the penalty of non-compliance? • What should be the condition on price of SEE in the market?
Incentive disbursement mechanism	<ul style="list-style-type: none"> • What should be the requirement for manufacturers to claim incentives? • How regular should the incentives be disbursed?
Monitoring & Verification	<ul style="list-style-type: none"> • How to verify the quantity of SEE produced and sold by the manufacturers • How to monitor the performance of the SEE sold by the manufacturers?
Evaluation	<ul style="list-style-type: none"> • How to evaluate the impact of the program?
Branding & Marketing	<ul style="list-style-type: none"> • How to create consumer awareness around the program and market the SEE?
Institutional Framework	<ul style="list-style-type: none"> • How to effectively assign roles and responsibilities of all the functions related to the program?

Table 5: Program Design and Implementation Steps

4.1.2 Utilities Funding

The second source of funding for SEEP can be from utilities through recovery from electricity tariff. The main advantage of obtaining funding from electricity tariffs is the sustainability of the funding. As long as the benefits of the program accrue to the electricity customers, the regulators are unlikely to discontinue funding SEEP through the tariffs unlike the central government budget allocation. However, if the source of funds is electricity ratepayers, then the key stakeholders – regulators, utilities, and customers’ representatives – must agree that this use of the funds is appropriate. In countries like India, electricity is regulated at state level. Hence, unlike the central government 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 SEEP. This is a much larger and longer effort as compared with the central government alternative. It has to be

noted that even if the funding may come from utilities, the key features of SEEP should remain unaltered: the program should be run by the central government agency and the incentives directed to manufacturers. As we saw in section 2.3, these features allow the benefits of SEEP; low transaction costs, low incentives and reduced complexity in monitoring and verification.

4.1.3 International Climate Finance

A third possible source of funding can be a number of bi-lateral and multi-lateral climate funds. These funds are mostly directed to developing countries to help them develop and promote clean technologies among other objectives. They are fairly sustainable and the transaction costs are generally low. However, this may vary from one fund to other. An additional advantage of these funds are that they are well-managed by trustees like World Bank. These organizations have expertise in designing and executing programs in different countries which they can bring to SEEP along with the funding. For example, the SEEP for ceiling fans in India is funded by World Bank administered Clean Technology Fund (CTF)²⁹

4.1.4 Choosing the Funding Mechanism

The actual choice of the funding mechanism for SEEP will depend upon a number of country-specific factors as well as the availability of different types of funds. However, to facilitate a quick start of the program, it is recommended to secure funding from the central government or from international climate finance at least for the initial one or two years. As SEEP starts realizing its objective of market transformation, it will be easier to convince all the stakeholders - regulators, utilities and customers' representatives - to approve funding through recovery from tariff. The funding can then be sourced from utilities, which is a more sustainable type of funding.

Funding

- *The funding should be sustainable.*
- *The transaction costs in securing the funding should be minimized.*

4.2 Technical Specifications

Technical specifications of SEE qualifying for the financial incentive should be established. The technical specifications should include the aspects related to the performance and energy consumption of SEE. For example, in India, an average ceiling fan consumes 70W of electricity and delivers air at the rate of 210 cubic minutes per minute (cmm). A super-efficient fan should be expected to deliver same rate of air but consuming less electricity. Hence the technical specifications of super-efficient fans should include the electricity consumption as well as performance. Determining the appliance specific technical specification can be done by a technical committee comprising of all the stakeholders of SEEP including relevant government agencies, manufacturer/industry associations, industry experts, academicians, testing laboratories, consumer groups etc. Such a technical committee can either be formed specifically for SEEP or it can be an

²⁹<https://www.climateinvestmentfunds.org/cif/node/2> (Last accessed on 7th February 2013)

existing one formed to determine the national performance standards for that appliance category. This technical committee can consider the points already mentioned in the section on identification of super-efficient appliances (3.2.3). The basis for the determining the specifications can be the comprehensive techno-economic analysis of all the available energy efficiency options, as described in section on cost benefit analysis (3.3).

The specifications should be aligned with the basic objective of SEEP. The aim is not to introduce the most efficient appliance possible through advanced technology. Rather, it is to achieve market transformation to a cost effective, most efficient appliance commercially available in the market.

The specifications should also be technology neutral. Manufacturers should be given the freedom to exercise their ingenuity to devise alternative ways to meet the technical specifications. For example, super-efficient ceiling fan can be realized through various approaches: the design of the blades can be more aerodynamic; the efficiency of induction motor can be increased; a new motor technology called Brushless DC (BLDC) can be used. BLDC motors may require some additional specifications on parameters like power factor and total harmonic distortion (THD). These should be addressed in the final technical specifications. However they should not exclude other design improvement approaches. The risk of specifying a technology for SEE is that it results in restrictions on manufacturers for developing more innovative, cost-effective measures.

The technical specifications should also prescribe a warranty for SEE. It is recommended that the warranty should be higher than the warranty provided on the normal appliances. The SEE is new to the market and hence customers may be hesitant about its performance. The higher warranty will build their trust in SEE and help increasing the market share of SEE.

Additionally, if possible, the SEE may also be required to enhance performance in addition to energy efficiency. In many cases, EE is not a top buying criterion. Hence, a SEE which also has a superior performance as compared to a normal appliance will have a more market appeal. For example, consumer generally does not consider EE while buying a ceiling fan but rather looks for design, colour and air-delivery. If the SE fan is specified for more air-delivery, it can be marketed as the fan which delivers more air which may appeal more to consumers than fan that consumes only less energy. However, enhancing performance will also add to the cost of SEE. The technical committee can take a decision based on the desirability of such superior SEE in the market

Finally, it is recommended to identify the technical specifications of SEE early in the program design phase and announce them to manufacturers. This will give manufacturers some time to develop the SEE while the program is designed and approved by the government.

Technical Specifications

- *A technical committee of all the stakeholders including manufacturers should identify technical specifications early in the program design.*
- *The SEE specifications should be a right balance between cost and efficiency.*
- *The SEE specifications should be technology neutral.*
- *The SEE specifications may require a better performance than normal appliance.*

4.3 Incentive Determination Mechanism

One of the key steps of the program design is identifying the mechanism to determine the amount of financial incentive per unit SEE to be provided to manufacturers. In general, there are two approaches to determining the incentive: (1) through competitive bidding to ‘discover’ the lowest incentive that would be required by manufacturers; and (2) thorough analysis and discussion to determine the incremental manufacturing cost.

In the competitive bidding mechanism, the technical specifications of SEE would be announced and bids would be solicited for interested parties to produce and sell SEE. The bidders would quote the minimum incentive they would require, and the party with the lowest bid incentive would win.

In an approach through analysis and discussion, the incremental cost of making SEE would be estimated through analysis, and the incentive level set accordingly. Any manufacturer could participate in the program at any time, and would get the same incentive as any other manufacturer.

Both the approaches have advantages and dis-advantages which we have compared below. While comparing these two approaches, it is important to remember that the intent of the process is not simply to reduce costs for SEE down to the bare minimum. While low cost is certainly desired, the main objective of SEEP is to maximize the savings at a reasonable cost, and facilitate a rapid market transformation by taking most of the manufacturers along.

4.3.1 Advantages of Competitive Bidding

- Competitive bidding helps in the ‘discovery’ of the lowest cost approach to meet the desired specifications of SEE.
- Bidding rewards innovators and risk-takers because they would be more likely to win in the bidding process.
- Bidding is an easier way to estimate the incremental manufacturing cost, because only a preliminary analysis will be required to estimate a reasonable range for the bids. No negotiations with manufacturers would be required. In contrast, under the analysis based approach, the incremental manufacturing cost for super-efficient appliances would need to be estimated. Because of information asymmetry between manufacturers and program designers, it would require an additional effort to arrive at a reasonably accurate estimate of the actual incremental costs.

- Bidding is consistent with many standard government procurement processes where tenders are floated, and the lowest quoted price wins the contract to supply the particular good or service. Once a competitive bidding process is complete and the winning bidder selected, no additional checks would be required by the government, resulting in speedy implementation of the program.

4.3.2 Dis-advantages of Competitive Bidding

- The common form of bidding would result in a single manufacturer supplying the SEE. This would be risky because if the winning bidder were to default, the program would come to an end. Therefore, we would have to devise ways so that we don't put all our eggs in one basket. However, the bidding system can be designed differently so that it would be possible to have more than one supplier of SEE. The reverse bidding mechanism developed by the World Bank for SEEP in India can be one such example (see [Box H](#)).
- In any case, if only one or a small group of manufacturers participate in SEEP, the overall savings of energy would be reduced. The more manufacturers that participate in the program, the greater the number of SEE sold, and consequently the greater the energy savings. This could be a significant disadvantage for competitive bidding, because a major aim of the program is to maximize energy savings.
- Non-participating manufacturers could sabotage the program and the product through false propaganda.

4.3.3 Choice of the Incentive Determination Mechanism

The final choice of the mechanism depends upon a number of country-specific factors such as the political scenario, the market structure and others. A well-designed competitive bidding approach with adequate checks can be a good approach to follow. However, some countries may also adopt the approach of deciding incentive through analysis and discussion in order to accommodate larger number of manufacturers and widen the reach of the program. A hybrid approach can also be adopted. In this approach, the program can be started by providing incentives based on analysis and discussions. The incentives can be continued for a year and two and then competitive bidding can be introduced

Incentive Determination Mechanism

- ***Competitive Bidding and, Analysis & Negotiations are two approaches to decide the amount of incentive per unit SEE.***
- ***Multiple manufacturers should be able to participate in the program.***
- ***Incentive level should be the right balance between cost and the potential to maximize savings.***

Box H : Reverse Bidding Mechanism

A reverse bidding mechanism has been proposed (not yet finalized) for SEEP in India. The mechanism was developed by World Bank and Deloitte. The first phase of the program will cover 5 million ceiling fans over three years. In this mechanism, the Bank will fix a maximum level for the incentive per unit super-efficient (SE) fan based on a preliminary cost analysis.

The bidders will be requested to quote on two parameters:

- a) Discount from the maximum level of incentive and
- b) Number of SE fans that the bidder can manufacture in 3 years.

The final incentive per unit SE fan for a bidder will thus be maximum level of incentive minus the discount offered in bidding. In order to enable multiple winners in the bidding process, manufacturers are allowed to quote the production quantum of SE fans only within specified limits of 0.5 million to 2 million SE fans. Further, bands of allowed production quota are created as follows.

Band	Min. Production (million units)	Max. Production (million units)
1	0.5	2.0
2	0.5	1.5
3	0.5	1.0

Only two bidders will be selected in band 1 and band 2 each. The process allows minimum four bidders and maximum 6 bidders as winners.

The bidder with highest discount (i.e. lowest incentive) will be granted the requested production quota. The subsequent bidders will be allocated their requested production quota till the total quantum of 5 million ceiling fans is achieved.

4.4 Incentive Criteria

Independent of the choice of the incentive determination mechanism, there are a few points regarding incentives that should be considered.

There should be eligibility criteria for manufacturers to participate in the program and avail incentives. The primary goal of SEEP is to achieve market transformation. Hence, the participating manufacturers should have capability to manufacture SEE, an extensive dealer and retailer network to effectively market SEE throughout the country, and a strong brand image that they would want to protect by producing and selling good quality SEE. The eligibility criteria should also keep out the 'fly-by-night' operators who may get attracted to the program due to financial incentives. However, the eligibility criteria should not be too restrictive such that it only allows major manufacturers. The program requires innovation which the smaller players can be more flexible to adopt. The final decision on criteria can be taken based on market data. Indicators like annual sales, annual turnover and others can be used.

There should be a specified maximum retail price limit for SEE. One of the assumptions of the program is that incentives received by manufacturers will be passed on to consumers due to the competition between multiple participants in the program. However, there may be a possibility of manufacturers taking the incentive and selling the SEE as a niche product at premium price. In order to avoid this situation, it is recommended to specify a maximum price at which manufacturers can sell SEE in the market. The specification of the maximum price can be based on market data on price of normal appliances. A market survey can be useful in determining the maximum market price. The survey can identify the price brands of the appliances available in the market. The price of SEE can be fixed near the median of the price range. One approach can be to fix the price slightly higher than the median. This is because consumers normally compare the quality of the product with its price. Hence, the manufacturers can sell the SEE by distinguishing it from other models by pricing it slightly higher. However, as mentioned earlier, the price should not be significantly higher which makes SEE a premium product.

Incentives should be reviewed periodically. As the sales of SEE increase, the economies of scale will enable manufacturers to lower the production cost. This will result in reduction of the incentive required. Hence, incentive levels should be corrected accordingly. However, the period of review should be fixed a priori. Manufacturers should be assured of the determined incentive level in order to plan their production. In case of SEEP for ceiling fans in India, it is proposed to reduce the incentive level by 15% after two years.

Incentive Criteria

- ***There should be eligibility criteria for manufacturers to participate in SEEP.***
- ***There should be a specified maximum retail price for SEE.***
- ***Incentives should be reviewed periodically.***

4.5 Incentive Disbursement Mechanism

It is crucial to determine the point at which incentive is given to manufacturers. One approach is to give incentives to manufacturers based on production of SEE i.e. at the point when the product leaves the factory. The other approach is to give incentives to manufacturers based on sales i.e. at the point when the consumer buys SEE. Both the approaches have its advantages and limitations. The advantage of the production-based approach is its ease of validation. A manufacturer will have only limited manufacturing units and it will be easy to verify the number of the products at the premises of these units. Manufacturers will prefer this approach since it assures them quick disbursement of incentive. The limitation of this approach is production does not necessarily indicate the sales of SEE. A manufacturer may produce SEE and then store them in his warehouse. Thus this approach does not confirm the sale of SEE. The advantage of the sales based approach is that manufacturers are paid only when the consumer buys SEE, which is the primary objective of the program. However, this approach is difficult to implement due to the large number of retailers in the market. A mechanism should be developed to track the sales through all these retailers. Advanced technology like Radio Frequency Identification (RFID) can be utilized to track each SEE. However, it will add to the administrative cost of the program. If the mechanisms that can make the sales based

approach economical and easier to implement are already in place, then it can be the first choice. Otherwise, it is recommended to have a production-based approach to give incentives as it is easier to implement. There can be some cross-checks on sales through retailer visits and gathering customer data.

The period of the incentive disbursement should also be decided. Manufacturers would prefer the period of disbursement as short as possible. One of the factors affecting this decision can be the verification mechanism in place. As described in the next sub-section, it is preferred that the verification of claims by manufacturers is done through existing system of tax. The reporting period of these systems will then decide the minimum period of funds disbursement possible.

Setting the performance criteria for the manufactures is very important. The performance should be on two counts: one is the quantity of fans and second is the quality of fans. Both can be monitored through M&V mechanisms as described in the next sub-section. There should be a criteria set for both the parameters. If the manufacturer is not able to fulfill these criteria, then there won't be any payment of incentives. Additionally, the manufacturers should also pay a penalty for non-compliance. The penalty should be high enough to result in a strict deterrence. In order to ensure the payment of penalty, the manufacturers should be asked to provide a bank guarantee. Also, the list of defaulters can be made public and they can be black-listed from all the government programs. The severity of the penalty can lead to manufacturers ensuring the quality and quantity of the SEE.

Incentive Disbursement Mechanism

- *The incentives can be given to manufactures at production stage or at the sales stage.*
- *The choice of disbursement mechanism should be influenced by cost, simplicity and ease of implementation.*
- *The period of disbursement of incentives should be fixed a priori.*
- *There should be performance criteria for manufacturers and severe penalty in case of default.*

4.6 Monitoring and Verification (M&V)

Two parameters should be subjected to M&V: (a) Quantity of the SEE sold and (b) Quality of the SEE sold.

We describe both in the following sub-sections.

4.6.1 Quantity

The manufacturers will get incentive based on the number of SEE produced and sold; more the SEE claimed more the incentives. Hence, it is imperative to cross-check manufacturers' claims on SEE produced while availing incentives. As discussed in previous sub-section, the incentives can be disbursed based on production or based on sales. In either case, it is recommended to use existing systems like excise duty or sales tax to track the SEE rather than developing a new system. There are several benefits of this approach. First, these systems have usually been in place for long time and have evolved to take care of the loopholes. Second, a manufacturer will be much more comfortable with the existing system rather than subscribing to a new system. It reduces the hassle for him. It also reduces the administrative cost of the program. However, care should be taken to study these systems and evaluate whether they can be utilized for SEEP. For example, in SEEP for ceiling fans in India, it was initially proposed to use excise record system for quantity control, since all the manufacturers are required to keep the records. However, in interaction with manufacturers, it was revealed that some states had offered excise free zones for manufacturers wherein the paying the excise and keeping the records is not mandatory. Hence, the system of Central Sales Tax (CST) will be used to monitor the quantity of SEE under the program.

4.6.2 Quality

The M&V mechanism should ensure that the SEE fulfill the specified technical criteria. This would require adequate number of testing laboratories appropriately accredited to test SEE.

A testing protocol must be developed for the SEE. Generally, there are national standards applicable to all the appliances. These standards prescribe the performance parameters and the protocols and methods to test them. These standards can be adopted for SEE as well. The standards may need to be modified to address any specific issues regarding SEE esp. related to parameters on energy consumption. The technical committee described in section [4.2](#) can make these modifications. See [Box I](#) which describes how testing protocols were finalized for ceiling fans for SEEP in India.

The testing mechanisms should be identified once the test protocols are set. There are two types of testing: (a) Conformance or Type testing and (b) Check testing.

Conformance or type testing can be done initially to certify whether the product meets the technical specifications for SEE. This should include all the standard tests conducted for product performance and safety. A small sample of product can be checked at this stage. Once the product passes all the tests, it can be certified as SEE and manufacturers can start producing them on the assembly line.

Check testing is done after manufacturer starts producing and selling SEE in market. The testing should be done randomly at three levels: manufacturer, retailers and consumers. A random sample of SEE can be picked from each of the three segments and tested. At this stage, only the parameters related to energy consumption and performance can be tested. It is not required to conduct the comprehensive tests on safety and other features. If a certain number of SEE fail the test, then the payment of incentives can be stopped. The criteria for passing the random check testing and the penalty should be decided and clearly communicated to manufacturers. In some instances, it may be difficult to pick the sample at the customer level, since the SEE maybe already installed in their homes. In that case, information can be used from the customer feedback as described in 5.6.1.

However, the customer evaluation of the product should not be directly related to the payment of incentives as it is not based on any standard tests. The feedback can be used to investigate more on the performance through additional testing.

Monitoring & Verification (M&V)

- *M&V should be conducted for Quality and Quantity of SEE.*
- *Existing mechanism like tax systems can be used to verify manufacturer's claims on SEE production.*
- *Adequate testing laboratories with appropriate accreditation should be identified.*
- *A testing protocol should be developed for SEE.*
- *Testing mechanism should include one-time conformance or type testing followed by random check testing at manufacturer, retailers and customer level.*

Box I : Developing Testing Protocol for Ceiling Fans in India

Bureau of Indian Standards (BIS) prescribed IS 374 is the standard that specifies requirements and methods for tests of ceiling fans in India. The international standard was adopted in 1979 and amended 6 times. The latest, 7th, amendment is in process of approval by BIS. However, interactions with manufacturers revealed certain issues with IS 374.

The air-delivery is an important parameter of ceiling fan performance. An air-delivery of 210 cubic meters per minute (cmm) at full speed is generally accepted to be the minimum required for the comfort of the consumer in India. Hence IS 374 specifies the power requirement that ensures 210 cmm of air-delivery. The SE fans were also expected to deliver 210 cmm of air but with much lower power consumption. The testing of the SE fans was initially decided to be done using IS 374. However, manufacturers expressed concern regarding the consistency of test results measured according to IS 374. Since the incentive payment is linked to the results of the tests, this is a very important issue.

IS 374 does not specify controlled testing room conditions. Hence, the tests are conducted at ambient conditions. Air-delivery from the ceiling fan varies with air-density which in turn varies with ambient conditions like temperature, relative humidity and pressure. Hence the tests conducted at different locations in India as well as at different times of the year resulted in different air-delivery measurements for the same ceiling fan. One approach to solve this issue was to make the controlled testing room procedure mandatory for ceiling fans. However, this would require involve building labs with such facilities which was an investment and time intensive activity. Hence it was decided to find an alternative approach.

Several approaches were discussed based on theoretical analysis and weather data. Finally, it was decided that the SE fan will be required to meet the performance parameters at certain minimum set of ambient conditions. These ambient conditions will correspond to those conditions that result in maximum possible air density. This will require setting lower limits on temperature and humidity and a higher limit on pressure. A consensus was reached on following limits: 20 degree Celsius and above for temperature, 20% relative humidity and above, and sea level and above. This was included in the test protocol for SE fans.

Some other issues regarding type of instruments, its calibration and other which were not addressed in IS 374 were also modified after interaction with manufacturers. Thus a new test protocol based on IS 374 was developed for SE fans.

4.7 Evaluation

A periodic evaluation by an independent, third party is essential to monitor the progress of the program. It can be conducted annually or maybe twice in a year. A deemed savings approach as described in section 3.2.5 can be used in estimating savings achieved from the SEEP in the evaluation

period. One important aspect of the evaluation of energy efficiency programs is free-ridership. Free-ridership identifies those beneficiaries of the program who would have implemented energy efficiency measures even in the absence of a program. In case of SEEP, there is no free-ridership as far as consumers are concerned. The SEE won't be available in the market in absence of SEEP. Hence, there is no possibility of consumers buying SEE in absence of SEEP.

The evaluation should also try to quantify the indirect benefits of the program. SEEP may result in increased awareness of energy efficiency among consumers as well as retailers. The introduction of SEE in market will lead to increase in the weighted efficiency of appliances. This may lead to tightening in the standards for the appliance category. Additionally, the evaluation should also be on the administrative process of SEEP. All the people involved with the program should be interviewed: manufacturers, retailers, consumers and even the program managers; to get ideas on stream-lining the administrative processes. The inputs from these periodic evaluations should be used to do any mid-term corrections in the program. Customer feedback is a crucial element of the evaluation and is discussed next.

4.7.1 Customer Feedback

If a sales based approach for monitoring is adopted, the information on customers will be easily available. If a production based approach of monitoring is used to track SEE, an additional mechanism should be adopted to get the information on customers. The warranty of the product can be subjected to the customer registration. However, for many small appliances like ceiling fans, in countries like India, there is no registration required for warranty. Retailers and manufacturers sort it out on an informal basis. Making the registration mandatory can be perceived as a hassle by consumer making him stay away from the SEE. Alternatively, consumers can be voluntarily asked to register on the program website. There may be some kind of lottery schemes to incentivize him to register.

The customers can be asked to fill out survey on different aspect of the program: performance of SEE, availability, awareness and knowledge of salesman, and others. These can be used to evaluate the program.

Another alternative to evaluate the consumer awareness can be to conduct a random survey of consumers planning to buy the SEE. They can be asked whether they are aware of the SEEP program, the technical specifications of SEE, the benefits of SEE and other aspects.

Evaluation

- ***Periodic evaluation of SEEP should be conducted by an independent third party.***
- ***The savings achieved can be calculated using the deemed savings approach.***
- ***Indirect benefits of SEEP should also be measured.***
- ***Administrative processes should also be evaluated.***
- ***Customer feedback is an essential element of the evaluation.***

4.8 Branding and Marketing

Branding and Marketing is crucial for the market transformation to SEE. The SEE should distinguish itself from the other models. This can be done by designing a creative label for SEE. The label should have information on energy consumption and savings. In case, there is already a standards and labeling program in place, SEE label should be distinct from the other labels.

The SEE should have a creative marketing campaign. The various media platforms can be effectively used to create awareness among the customers. Manufacturers should be mandated to spend a certain amount on the marketing campaign. The marketing budget can be complemented by some money from the program cost. The government can endorse SEE in the marketing campaign which can increase the credibility of a product significantly. At the same time, manufacturers should equally participate in the campaigns with their well established brands and logos. This will add to the credibility of SEE and also put some liability on the manufacturers. They will be keen to maintain the quality of SEE since their brands will be at stake.

The retailers and other intermediate actors are traditionally ignored in a marketing campaign. However, they are very crucial in influencing the buying decision of the customers. They should be provided adequate training in SEE. There can be tie-ups with retailer chains to promote SEE through prominent display. In countries like India, intermediaries like electricians play a crucial role in decision making. Appliances like ceiling fan are mostly bought in consultation with electricians. Hence, the awareness campaign should also target these intermediaries

Branding and Marketing

- ***SEE should have a distinct label with the information on energy consumption and saving.***
- ***A creative marketing campaign should be designed to generate awareness among consumers.***
- ***Government endorsement on marketing campaign can increase the credibility***
- ***Retailers and other intermediate actors should be included in the campaign.***

4.9 Institutional Framework

SEEP, being a national level program, will involve large fund flows to manufacturers. The key sources of funding identified here are tax payers (in case of central budget allocation) or rate payers (in case of utilities funding). 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 SEEP that results in transparency and accountability with respect to all of its operations. The various functions described in the previous sections can be categorized into five broad functions: (1) oversight of the program (2) program design (3) program implementation (4) monitoring & verification and (5) process evaluation.

As with the other aspects of the program, the framework for a specific country will depend on a number of country-specific facts.

One possible institutional framework is shown in Table 6. The framework envisages three institutions to be involved in the program. A central government agency will be the agency responsible for the program and will do the program design and overall supervision. An external agency can be hired to do funds management and M&V according to the guidelines in the program design. The advisory committee can include policy-makers, senior bureaucrats, academicians and people from civil society organizations and review the progress of the program periodically and make suggestions. The committee can review the evaluation reports conducted by an independent agency.

Agency	Broad Functions	Responsibilities
Central Government Agency	<ul style="list-style-type: none"> • Program Design • Oversight 	<ul style="list-style-type: none"> • Program design • Overall supervision of the program • Mass outreach • Reporting progress every six months to the Advisory Committee. • An annual third party evaluation of the program
Fund Management and M&V Agency	<ul style="list-style-type: none"> • Program Implementation • Monitoring & Verification 	<ul style="list-style-type: none"> • Evaluation of proposals from manufacturers • Type testing & signing of contracts with selected manufacturers • Verification of production and sales data • Handling funds including disbursement • Random Check testing of fans • Creation and maintenance of customer database
Advisory Committee	<ul style="list-style-type: none"> • Program Evaluation 	<ul style="list-style-type: none"> • Review of progress every six months, and suggesting measures to improve effectiveness of the program • Review of the annual program evaluation study

Table 6: An example of an Institutional Framework for SEEP

4.10 Transparency and Accountability

Transparency and Accountability is extremely crucial in a program like SEEP which involves large fund flows to manufacturers. The first step is to create a website completely dedicated to SEEP where all the information related to SEEP should be available to the public. Making all the data related to SEEP public will increase the accountability of the government or the agency conducting the program

The process of program design should be documented with the rationale behind each and every decision clearly explained³⁰. Also, all the meetings with manufacturers and other stakeholders during the program design stage should be recorded with the minutes of the meetings available on the website.

The program design document should be available on the website and open to public comments. This is important since the funding will be either through tax payers or rate payers. Comments from a much wider section of society such as civil society organizations, consumer organizations and others will be helpful in finalizing the program design. It will also be helpful to write a document which is easy to understand to the general public. This can be in the form of Frequently Asked Questions (FAQ) on SEEP³¹.

Once the program is launched, all the information on sales from manufacturers should be put on the website. Also the results of the check testing should be made public along with the action taken on the manufacturers if any. Finally, the periodic evaluation reports should be available on the website too.

Transparency and Accountability

- ***A website dedicated to SEEP should be created and all the data related to the program should be made available for public.***
- ***The program design process should be documented with rationale behind each decision clearly explained.***
- ***Program design document should be open to comments from a wider section of society including general public and civil society organizations.***

³⁰ For example, please refer: Singh Daljit, Sant Girish, Chunekar Aditya, Pednekar Adwait, Dixit Shantanu, *Development of Super-Efficient Equipment Program (SEEP) for Fans*, July 2012. Available on: <http://www.prayaspune.org/peg/publications/item/175.html> (Last accessed 13th Feb 2013)

³¹ For example, please refer: Sant Girish, FAQ on SEEP. Available on: <http://www.prayaspune.org/peg/publications.html>