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Introduction to State-wide Rebate based Incentive Program for Utility Companies for Promoting Energy Efficiency in India

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Highlights

- Rebate based Incentive Program will provide benefits to the end-users to incorporate energy efficiency practices.
- These programs will be beneficial to all Residential, Commercial, and Industrial end-users.
- The incentive programs will be implemented by the State Electricity Regulatory Commissions, Distribution Companies, and State Designated Agencies.
- A case study has been presented that highlights the benefits of rebate-based incentive programs for Maharashtra, Gujarat, and Tamil Nadu.

Abstract

Energy efficiency penetration in the Indian market is driven by the policies and schemes implemented by the Bureau of Energy Efficiency (BEE), Energy Efficiency Services Ltd. (EESL), and various state governments. This paper aims to introduce a rebate-based incentive program for achieving energy efficiency in India. This paper also delves into the current demand-side management activities in India. The different steps involved in the evaluation of rebate-based energy efficiency programs have been presented in this paper. A case study has been provided to estimate the amount of energy savings and the avoided CO_2 emissions that could be achieved by the implementation of rebate-based energy efficiency programs for the states of Maharashtra, Gujrat, and Tamil Nadu. It is estimated that the proposed energy efficiency programs could achieve 5,346 million units of electric savings and 3.8 million tons of avoided CO_2 emissions across the three states.

Keywords: Energy efficiency program, rebate-based incentive, utilities, demand side management, decarbonization

Introduction

India has been experiencing a significant increase in electricity demand, with an annual growth rate of around 5% over the last five years. However, power generation has not kept pace with this demand, leading to a consistent energy deficit of 4-8% during this period. The imminent connection of the remaining Indian households without electricity access to the grid will further exacerbate the demand-supply gap. Additionally, it is projected that the market for electric vehicles (EVs) in the domestic sector will experience a compound annual growth rate (CAGR) of 49% until 2030 [1]. While increasing electricity generation is one solution to this problem, limited resources are a hindrance, which makes it imperative for India to adopt energy efficiency measures to reduce its demand for electricity.

At the state level, various actors such as the State Electricity Regulatory Commissions (SERC), Distribution Companies (DISCOMs), and State Designated Agencies (SDAs) established under the Energy Conservation Act can play a crucial role in improving India's energy efficiency. Given the diversity of factors such as consumer mix, power purchase profile, and load curve, it is essential for each state to develop its action plan for energy efficiency with the active involvement of all stakeholders. DISCOMs, which often struggle to meet their peak demands and incur financial losses, can benefit significantly from energy efficiency (EE) and demand-side management (DSM) activities. The following clarification is provided regarding the use of the term demand side management in this paper. DISCOMs conduct DSM activities to flatten the load curve, reduce peak demand, and improve system reliability and quality. In this paper, we have adopted an expanded definition of DSM to include EE and EC activities. Unless explicitly stated otherwise, any reference to DSM

activities should be understood to include Energy Efficiency and Energy Conservation activities. Through their extensive reach with consumers, DISCOMs can facilitate improvements in end-use efficiency and influence consumer behavior to reduce and manage their consumption.

In the past few years, there has been a surge in EE/DSM endeavors undertaken by DISCOMs, SDAs, and SERCs following the introduction of DSM regulations by several states. DISCOMs have been setting up DSM cells, devising action plans, and conducting pilot programs. Similarly, state governments have been introducing various orders on energy efficiency while also establishing energy conservation missions.

This paper presents an overview of the energy efficiency, energy conservation, and demand-side management activities carried out by SERCs, DISCOMs, and SDAs in three states of India, namely Maharashtra (MH), Gujarat (GJ), and Tamil Nadu (TN). The states were selected based on their high electricity consumption. This paper also presents an overview of incentive programs in different countries used for supporting energy efficiency projects. Based on this, a rebate-based incentive program is presented in order to develop a coordinated and coherent strategy for scaling up energy efficiency, energy conservation, and demand-side management activities at the state level in India.

A case study is conducted in this paper to calculate the approximate amount of electricity savings that can be achieved with a rebate-based incentive program for the states of Maharashtra, Gujarat, and Tamil Nadu.

An overview: DSM activities in India

Various DSM Programs are being carried out in India. The different Programs by EESL and SERCs, DISCOMs, and SDAs in Maharashtra, Gujarat, and Tamil Nadu are summarized in Table 1.

Table 1: Summary of DSM programs

Organization	Program Name	Description
Bureau of Energy Efficiency	Municipal Demand Side Management (MuDSM) [2]	Reduction of energy in utility services like street lighting, water pumping, sewage treatment, and in various public buildings.
	Perform, Achieve and Trade (PAT) cycles [3]	Designated consumers are given targets to reduce their energy consumption and trade energy savings certificates.
Energy Efficiency Services Ltd. (EESL)	UJALA [4]	Distributing LED bulbs, LED tube lights, and energy-efficient fans to households to replace conventional and inefficient models.
	Solar Induction Cooktop [5]	Proposing a solar-based induction cooking solution for Indian cooking applications through carbon financing.
	National Motor Replacement Program (NMRP) [6]	Establishing an infrastructure for the supply of high-efficiency motors in compliance with the IE-3 standard.
	Street Lighting National Program (SLNP) [7]	Replacing traditional streetlights with energy-efficient LED streetlights and recovering costs through energy savings.
	Agriculture Demand Side Management (AgDSM) [8]	Distributing energy-efficient agricultural pumps and smart control panels for remote operation, reducing energy consumption.
	Super-Efficient AC Program (ESEAP) [9]	Offering super-efficient air conditioners at rates equivalent to the most energy-efficient models, reducing cooling costs.
	Atal Jyoti Yojana (AJAY) [10]	Installing solar LED lights in areas with inadequate power coverage.
Maharashtra Electricity Regulatory Commission	Time of Day (ToD) tariff	Introduced ToD tariff for industrial consumers, incentivizing load shifting and offering rebates based on consumption, contracted demand, and load shedding hours.
Tata Power Company – Distribution (Maharashtra) [11]	Appliance Exchange Program	Implements appliance exchange program for replacing inefficient appliances like fans, tubelights, refrigerators, and AC.
	Thermal Energy Storage Program	Implements Thermal Energy Storage (TES) Program for energy storage.
	Manual Demand Response Program	Offers a manual Demand Response (DR) Program to curtail load.
	Energy Audit Program	Provides Energy Audit Program for industrial/commercial sectors.

	Heat Pump Program	Implements Heat Pump Program for industrial/commercial sectors.
Brihan-Mumbai Electric Supply (BEST) [12]	Pilot DSM Initiatives	Conducted pilot DSM initiatives, including replacements of fluorescent tubes, ceiling fans, & bulbs with energy-efficient options.
	LED Tubelights Program	Implemented a program for replacing conventional FTLs, conventional bulbs and CFLs with LED tubelights.
	Star-labelled Fans Program	Implemented a Program for replacing conventional ceiling fans with star-labelled fans.
Maharashtra State Electricity Distribution Company Limited (MSEDCL) [12]	Ceiling Fans Replacement Program	Replaced inefficient ceiling fans at sub-stations and section offices.
	Agricultural Pump-set Replacement Program	Conducted a pilot project for replacing inefficient agricultural pump-sets.
	CFL Distribution Program	Facilitated the distribution of CFLs in Nashik.
	Agricultural DSM through ESCO-based Program (Pilot)	Partnered with BEE for agricultural DSM through ESCO-based Program in a pilot project.
Maharashtra Energy Development Agency (MEDA) [12]	Street Lighting and Water Pumping Scheme	Achieving energy savings in street lighting and water pumping systems using automatic light sensors, voltage dimmers, SCADA, and web-based monitoring.
	Save Energy Program	Provides financial assistance for energy audits in various sectors.
	Waste Heat Recovery	Encourages industrial units to generate power and utilize waste heat.
	Energy Conservation Pilot Project	Replacement of inefficient appliances, installation of renewable energy systems, and implementation of building energy management systems in government/semi-government/urban local body buildings.
Gujarat Electricity Regulatory Commission (GERC) [12]	Time of Use Charges and Time of Day DSM Tools	GERC approved time of use charges and time of day as DSM tools for DISCOMs, offering rebates for maintaining a power factor above 0.90 and imposing penalties for power factors below 0.90.
Madhya Gujarat Vij Company Limited (MGVCL) [12]	Feasibility Study for Agricultural DSM Pilot	Conducted a feasibility study for an agricultural DSM pilot in Anand, covering pump-sets connected to four feeders.
	Tube Light Replacement Program	Implemented Program to replace conventional tube lights with T5 tube lights in MGVCL offices.
	Co-incidental Peak Reduction Program	Implemented measures to reduce co-incidental peak in MGVCL.
	Power Factor Correction Measures	Implemented power factor correction measures in MGVCL.
Uttar Gujarat Vij Company Limited (UGVCL) [12]	CFL and Electronic Ballast Program	Purchased CFLs and electronic ballasts for energy conservation in UGVCL offices.
	Pilot Program for Pump-set Replacement	Conducted a pilot Program in nine talukas to replace old pump-sets with energy-efficient ones, resulting in energy savings.
	Load Forecasting and Load Management	Implementing load forecasting and load management in DGVCL.
Torrent Power Ltd. – Gujarat [13]	Appliance Replacement Program	Proposed Program to replace inefficient appliances with energy-efficient ones in government premises, health centres, and anganwadis.
	Reactive Power Management Program	Proposed Program for better reactive power management in diamond and textile industries by installing a current sensing automated switch with consumer-owned fixed-type capacitors.
Tamil Nadu Electricity Regulatory Commission (TNERC)	Peak Hour Charges and Low Power Factor Surcharge	Implemented peak hour charges or Time of Day (ToD) tariff in Tamil Nadu since 2002.
Tamil Nadu Generation and	Efficient Lighting Program	This includes replacement of conventional lights with efficient LED.

Distribution Corporation (TANGEDCO) [12]	Efficient Pumping Program	Low-efficiency pumps were replaced with higher-efficiency pumps.
	Pilot Studies on REbased DSM & Demand Response	Initiated pilot studies to assess the feasibility of implementing RE-based DSM and demand response strategy.
	Promotion of EnergyEfficient Appliances	Initiated Programs to promote energy-efficient appliances in the domestic and commercial sectors in Chennai.
Tamil Nadu Electrical Inspectorate (TNEI) [12]	LED Village Campaign	Conducted an LED village campaign to promote efficient lighting.
	Demonstration Project in SME Clusters	Conducted a demonstration project in SME clusters.
	Investment-Grade Audits and Energy-Efficient Replacements in Buildings	Conducted investment-grade audits in government buildings and replaced pumps, air-conditioners, and lights with energy-efficient alternatives.

An overview: Incentive programs for energy efficiency

This section presents an overview of the two main types of incentive instruments that are implemented worldwide, along with their respective funding sources.

Government funded programs

Incentive instruments

Incentive instruments play a crucial role in promoting energy efficiency, and they can be categorized based on their type and the intended recipients. Governments employ a range of incentives, including fiscal incentives, cash incentives, and low-interest financing, to drive energy efficiency initiatives. These incentives can be directed towards different actors in the supply chain, with downstream programs targeting consumers and upstream programs targeting manufacturers. Downstream programs, such as fiscal instruments like tax credits or deductions, are visible and appealing to consumers, but they may impose upfront costs and exclude low-income households. VAT reductions and consumer reward programs offer upfront discounts and rewards for purchasing energy-efficient products. Early retirement and direct installment programs replace inefficient appliances, leading to energy savings and environmentally friendly disposal. On the other hand, upstream programs focus on manufacturers by reducing transaction costs and encouraging the production of energy-efficient equipment. Tax credits are effective upstream incentives, while production subsidies may or may not impact equipment prices. However, upstream programs lack the engagement of consumers to raise awareness of energy efficiency opportunities and impacts. Overall, a combination of downstream and upstream incentives can be employed to maximize the impact of energy efficiency programs [14][28][29].

Funding sources

Government programs are often funded through central budgets or exceptional stimulus funds, while some may be financed by bonds, which are low-interest rate debt instruments. International financial institutions like the World Bank, the Clean Technology Fund, and the Global Environmental Facility can provide financial support to governments in developing countries. As budgets shrink during financial crises, policymakers seek alternative funding sources, such as revolving funds or earmarked taxes. Taxes raised specifically for energy-efficiency programs are even more powerful. Government funding from general budgets is subject to political forces, making it vulnerable to instability, and funding can be reallocated to higher-priority areas during times of financial crisis [14][28].

Ratepayer-funded programs

Incentive instruments

Increasingly, governments are mandating energy providers to deliver energy savings as part of their operations. This has led to the implementation of various incentive programs targeting different stages of the energy supply chain. These programs help lower production costs, improve product availability, and enhance the market penetration of energy-efficient products. Midstream programs, on the other hand, incentivize retailers through rebates to promote and sell high-efficiency appliances, thereby increasing their stock and sales. Downstream programs directly influence customer purchasing decisions by offering consumer rebates, on-bill financing, and direct installation programs. Consumer rebates reduce the upfront cost of energy-efficient appliances, while on-bill financing allows consumers to pay in installments through their electricity bills. Direct installation programs involve home visits, equipment installation, and financial assistance. These various incentive programs collectively aim to drive energy savings and promote the adoption of energy-efficient technologies [14][28].

Funding sources

Ratepayer-funded mechanisms can be either explicitly or implicitly paid for by ratepayers. Explicit mechanisms involve charging a defined amount as part of the consumer electricity rate, whereas implicit mechanisms require utilities to meet target savings by spending a share of profits on energy efficiency.

The explicit mechanism provides a price signal that encourages investment in energy efficiency and generates revenue that is earmarked to fund energy savings. Efficiency investments result in lower rates because they prevent or delay capital investments in generation capacity. While such an approach raises rates initially, customers recover the extra costs through electricity savings.

In market-based programs, the costs of energy-efficiency measures undertaken to meet regulatory targets are generally passed through in energy prices, which is done explicitly when a regulated distribution charge is implemented on energy prices. Additionally, utilities can offer energy-efficiency services as part of their business plans, providing to pay a portion of customers' up-front costs for efficient equipment via a loan whose cost will be entirely borne by the customer. The utility earns a profit by sharing a portion of the customer's energy savings [14][28].

Program evaluation

Program evaluations are rigorous and unbiased assessments carried out at regular intervals or as needed to evaluate the effectiveness of a program in achieving its intended objectives in a cost-effective manner. These evaluations are crucial tools for management to obtain a broader perspective on program performance and accountability beyond routine performance monitoring and reporting. Program evaluations are categorized into impact evaluation, which measures the program's effect, and process evaluation, which assesses the effectiveness of the program's design and implementation.

Impact evaluations provide evidence that outcomes have occurred and estimate the proportion of outcomes attributable to the program. Cost-benefit and cost-effectiveness evaluations, a form of impact evaluation, quantify economic benefits from energy savings and compare them to program costs, providing monetary or non-monetary values of program outcomes. Together, these evaluations help managers improve program operations, justify past investments, and decide on future investments.

This paper focuses on the impact evaluation of a downstream program because the main advantage of downstream incentive programs is that end-users directly receive the rebate amount as compared to upstream and midstream, where the cost of energy-efficient equipment is reduced through the rebate. In the context of an energy efficiency program, impact evaluation seeks to determine the extent to which the program has contributed to energy savings and other related benefits, such as greenhouse gas emissions, between a group of program participants and a control group that did not participate in the program, etc. This paper focuses on determining the energy savings and its Non-Energy Benefits (NEB), such as reductions in greenhouse gas emissions, market penetration of energy efficiency, equipment cost reduction, jobs creation, and increase in Gross Domestic Product (GDP) of any country.

Steps of an energy efficiency program for downstream customers

The flowchart indicating the different steps of the program evaluation is shown in Figure 1. The steps are explained in detail in the following section.

Phase 1: Program planning

Step 1. Funds collection for the program

Funds for a program can be sourced from either the government or rate-paying customers. This paper focuses on the ratepayer-funded program wherein a small additional amount for every kWh consumption is levied on the customers by the utilities. The amount percentage varies for every country and every state in some countries. A fixed percentage of electricity tariffs can be considered for fund collection. The additional charges for energy efficiency programs range from 0.003 cents/kWh to 0.3 cents/kWh with a median value of 0.11 cents/kWh in 22 USA states. However, some Utilities charge more than the median value. In Denmark, the funding for the Danish Energy Trust is derived from a dedicated energy savings charge of 0.006 Danish krone per kilowatt-hour (equivalent to 0.0011 USD/kWh) that is levied on households and the public sector [14]. The fixed percentage or energy efficiency charge can be decided after various discussions with different stakeholders.

Step 2. Identify the program areas for downstream customers

In energy efficiency programs, customer sectors include Industrial, Commercial, and Residential, and the selection of these areas should be based on historical data related to energy consumption patterns. The prioritization of areas for energy efficiency improvements should consider factors such as the potential for energy savings, costs, and environmental benefits.

Step 3. Decide the evaluation objectives

In an energy efficiency program, the primary evaluation objective is to achieve energy savings, which is quantified in terms of kilowatt-hours (kWh). Other objectives include identifying the coincident peak demand savings in kilowatts

(kW) and non-energy benefits (NEBs). These objectives provide the basis for assessing the effectiveness and impact of the program.

Step 4. Budgeting

Budgeting for energy efficiency programs involves different cost parameters, including rebates for customers, third-party evaluations to measure program impact and process effectiveness, management expenses, and other costs. Rebates are used to incentivize customers to participate in energy efficiency programs, while third-party evaluations are necessary to measure program effectiveness and ensure transparency. For residential and commercial equipment, rebates can be provided based on the capacity of the energy-efficient equipment like HP of motor, ton of air conditioning, volume of refrigerator, etc. For custom industrial applications, it is beneficial to provide rebates based on kWh of energy saved as energy efficiency projects involve complex equipment and processes.

The rebate amount is determined by calculating the incremental cost of acquiring energy-efficient equipment or implementing energy-efficient processes compared to the cost of baseline equipment or operating processes at baseline conditions. The incremental cost represents the additional expenses incurred to achieve higher energy efficiency. The determination of incremental cost in energy efficiency programs often involves conducting case studies on various equipment and processes.

In rate-funded energy-efficiency programs in the United States, a budget of 3-6% is allocated for independent third-party evaluators, which includes evaluation, measurement, and verification (EM&V). The 2012 CEE report stated that, on average, EM&V constituted 3.6% of the total budget [15]. In California, CPUC approved a budget of 4% (US$125 Million) of the overall portfolio budget for EM&V from 2010 to 2012 [16]. On the other hand, National Grid allocated an average of 2% (US$3.2 Million) of the portfolio budget for EM&V [17]. Management expenses are necessary for program administration and oversight, while other costs can include marketing and outreach efforts to promote program participation. Accurately budgeting for these costs is critical to the success of energy efficiency programs.

Step 5. Determine a timeline for completing the evaluation

The timeline should include clear milestones and deadlines for completing each stage of the evaluation, such as data collection, analysis, and reporting. The timeline should also consider any external factors that may affect the evaluation process, such as changes in program objectives, funding, or policies.

Step 6. Organizing program background data and records for use in the evaluation

This involves collecting and managing relevant information about the program's design, implementation, and outcomes. This data may include program plans, participant records, and energy consumption data. Organizing this data in a systematic and accessible way enables evaluators to use it effectively in the evaluation process.

Step 7. Develop and update Technical Reference Manuals (TRM)

A Technical Reference Manual (TRM) is a document that outlines the methodology for evaluating and measuring energy savings achieved through energy efficiency programs. It serves as a guide for implementing standardized energy savings calculation methods and measurement protocols. TRMs typically include a list of deemed measures, which are pre-approved energy efficiency measures and their corresponding energy savings values. TRMs provide a consistent and transparent approach to evaluating program performance and are used to establish baselines and verify energy savings achieved through various energy efficiency measures. This document must be updated every program year to incorporate new changes related to energy efficiency standards.

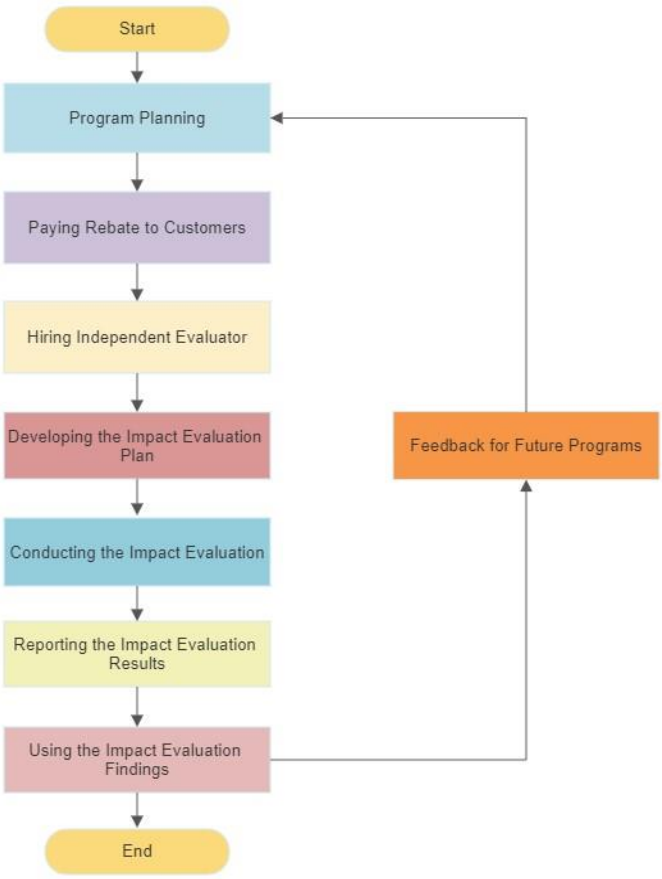

Figure 1: Flowchart for the evaluation program [18] [19]

Phase 2: Paying rebate to customers

Step 8. Collecting customer applications-

This step involves collecting data from customers who participate in the program, such as their contact information, details about the energy-saving measures they have implemented, and necessary documentation like equipment specification sheet and calculation methodology used for determining savings. This data is used to assess the effectiveness of the program and to identify opportunities for improvement.

Step 9. Sorting and approving the customer applications based on projected energy savings

Sorting customer applications based on projected energy savings is a crucial step in an energy efficiency program evaluation. This helps to identify high-performing measures and prioritize them for implementation, ensuring maximum energy savings. The sorting process involves reviewing and verifying the accuracy of the information provided by the customer in their application.

Sorting is only applicable when the rebate number of applicants is greater than the program-approved rebate amount. Different sorting conditions can be applied to provide equal opportunity to every customer to avail themselves of a rebate.

Step 10. Paying the rebate to the customers

After the applications are sorted and approved, the rebate amount is paid to the customer based on the application. The rebate amount can be paid in any form applicable. Direct Bank Transfer is an effective and faster way of rebate payment. It also leads to transparency between the end-users and the utility.

Phase 3: Hiring independent evaluators

Step 11. Put out tender to hire independent evaluator

This involves preparing the tender document, which would include the scope of work, evaluation criteria, qualifications, and experience required. After the tender document is ready, it will be advertised through the relevant channels. The scope of the project will need to be clearly defined in the Tender document. This will include the evaluation criteria and familiarity with relevant M&V protocols.

Step 12. Hire an independent M&V evaluator

After reviewing the received proposals and evaluating them against the selection criteria, the evaluator will be selected.

Phase 4: Developing the impact evaluation plan

Step 13. Define the evaluation outcome and the impact metrics

Defining the evaluation outcome and the impact metrics involves identifying the specific goals and objectives of the evaluation, as well as the metrics that will be used to measure the success and impact of the project. This may include measuring energy savings, greenhouse gas emissions reductions, cost savings, and other environmental or social benefits. Defining these outcomes and metrics provides a clear framework for the evaluation process and helps ensure that the project is being evaluated against its intended outcomes.

Step 14. Setting the time frame for the evaluation and reporting expectations

This involves establishing a clear timeline for when the evaluation process will take place, including data collection, analysis, and reporting. Reporting expectations outline what information needs to be included and how it will be presented.

Step 15. Preparing a technical evaluation plan and participating in the peer review process

This involves developing a detailed outline of the evaluation methodology, data collection procedures, analysis techniques, and reporting structure. Participating in the peer review process established for the plan entails having the plan reviewed by other evaluators to ensure its rigor and adherence to best industry practices.

Phase 5: Conducting the impact evaluation

Step 16. Perform sampling, data collection, and measurement and verification

This involves gathering relevant data and conducting measurements to assess the performance and impact of the project or program being evaluated. This can include conducting on-site inspections, utilizing monitoring equipment, and verifying the actual energy savings.

Step 17. Monitor the evaluation during the implementation

Monitoring the evaluation during the implementation phase involves regularly tracking and overseeing the progress and execution of the evaluation activities. This includes ensuring that data collection is on track, monitoring the quality and reliability of the data being collected, addressing any issues or challenges that arise, and maintaining communication with stakeholders involved in the evaluation process.

Step 18. Complete data analyses and calculations

This involves analyzing the collected data to derive insights and evaluate the performance of the project or program. This may include conducting statistical analyses, calculating energy savings, and cost-effectiveness ratios depending on the type of evaluation conducted. These results help in determining the effectiveness of the energy efficiency measures.

This paper focuses on the impact evaluation of energy efficiency. The flowchart for the impact evaluation process is presented in Figure 2. The evaluation of energy efficiency measures is energy savings in terms of kWh and kW reduction. Energy Savings are calculated in terms of Gross savings, which refer to the total energy savings achieved as a direct result of program interventions, without considering any adjustments or factors that might influence the actual energy consumption. Various methods like actual measurement & verification, deemed savings using TRM, or billing analysis can be used to determine the gross savings.

Measurement & Verification procedures and standards are provided by the International Performance Measurement and Verification Protocol (IPMVP), which are necessary for the verification of energy savings. IPMVP provides four options to quantify the savings (Option A, Option B, Option C and Option D) [21]

Net savings represent the energy savings achieved after accounting for any rebound effects, free ridership (a portion of program's energy savings that would occur without program intervention or incentive), spillover (energy savings that occur because of the program but are not part of the program's verified savings) or other factors that might influence the actual energy consumption and overall program effectiveness.

Step 19. Identify key findings

Identifying key findings involves summarizing the most significant and relevant results from the data analyses and calculations. These findings highlight the main outcomes, trends, successes, challenges, and insights gained from the evaluation. These findings provide information for decision-making and reporting purposes.

Step 20. Prepare draft and final report

Preparing a draft and final report entails compiling the evaluation findings, analyses, and key insights into a comprehensive document. The draft report serves as an initial version that undergoes review and feedback, while the final report incorporates any revisions and additions based on the feedback received. The report presents the overview of the evaluation process, findings, and recommendations, which in turn helps with the decision-making process for the energy efficiency program.

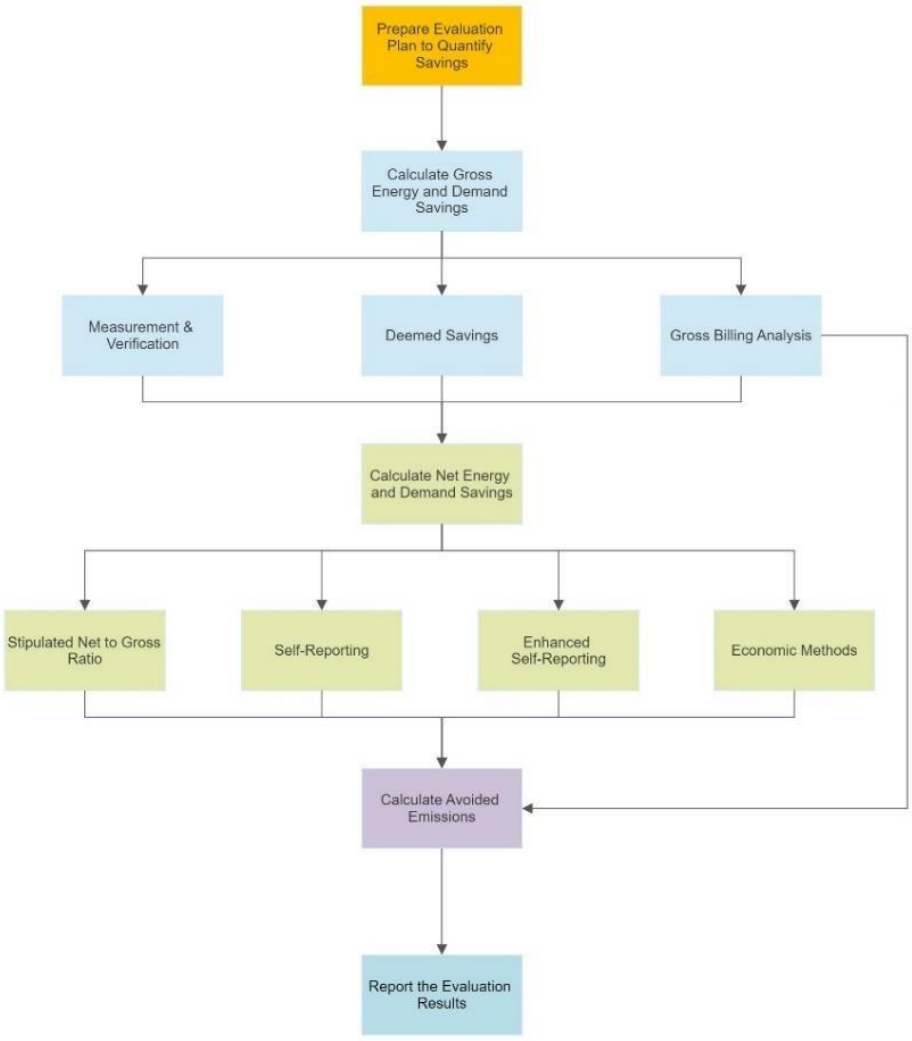

Figure 2: Flowchart for impact evaluation process of energy efficiency program [20]

Phase 6: Reporting the impact evaluation results

Step 21. Participate in peer review of draft evaluation report

Participating in the peer review of a draft evaluation report involves independent experts or evaluators in the field. These peers review the report for accuracy, rigor, methodology, and overall quality, providing valuable insights and recommendations to enhance the report's credibility and ensure that it meets the best industry standards practice.

Step 22. Publish final report

Publishing the final report involves making the completed evaluation report publicly available to relevant stakeholders, organizations, and the wider audience. This can be done through various channels, such as online platforms, project websites, industry publications, or government reports.

Phase 7: Using the impact evaluation findings

Step 23. Use the results to make decisions about the future program

Using the results to make decisions about the future program entails examining the evaluation findings and leveraging them to inform strategic choices for program improvement. This can include addressing the identified challenges and updating the program objectives to enhance the program's impact in the future.

Assumptions

1. The energy efficiency charge is considered to be 0.0011 US$/kWh [14]. Assuming a conversion rate of 80₹ per US$, the energy efficiency charge becomes ₹0.088 per kWh.The average electricity tariff of India was ₹6.15 per kWh in 2020 [22]. Using the historical average electricity tariff from 2009 to 2020, the electricity tariff for 2022 was extrapolated to ₹6.706 per kWh. The percentage of energy efficiency charge levied to customers will be 1.3%. So, a rounded value of 1% increase in electricity tariff, i.e., ₹0.067, is assumed as an energy efficiency charge.

2. The determination of rebate amounts is contingent upon several factors, including the sector in which the energy-saving equipment is deployed, its type, and other relevant considerations. Generally, rebates are calculated based on the amount of energy saved in kilowatt-hours during the first year of implementation. This approach ensures a straightforward and transparent payment mechanism directly linked to the actual energy savings achieved. By offering rebates based on per kWh saved, energy efficiency programs can effectively encourage customers to embrace energy-saving practices and technologies.
3. The determination of rebate amounts per kilowatt-hour (kWh) hinges on various factors, such as the incremental cost associated with energy-efficient equipment or processes. However, for the purpose of this paper, an alternative criterion is adopted due to the topic's scope. The primary rationale behind this alternative approach is rooted in the notion that the cost of saving one kWh of electricity is typically lower than the cost of generating or procuring an additional kWh of electricity. By employing this rationale, the selected criteria for rebate calculation ensures that the incentives provided align with the objective of promoting energy efficiency and optimizing resource utilization.
4. The average cost of procurement of electricity by DISCOMs of Maharashtra, Gujarat, and Tamil Nadu is assumed as the rebate amount.
5. Evaluation cost and management and other expenses are both considered as 5% of the total revenue generated.

Table 2: Case study: Energy savings and reduction in CO_2 emissions for FY 2022-23

Sr. No.	Parameters	Units	Maharashtra	Gujarat	Tamil Nadu
1	Annual electricity consumption for FY 22-23 [23]	Million Units	190,281	140,887	106,704
2	Energy efficiency charge in the tariff	₹/kWh	0.067	0.067	0.067
3	Annual revenue generated from the additional energy efficiency charge	₹ Crores	1,275	944	715
4	Management and other expenses (assumed)	%	5%	5%	5%
5	Evaluation expenses (assumed)	%	5%	5%	5%
6	The net amount available for rebate	₹ Crores	1,147	850	643
7	Rebate amount per kWh saved	₹/kWh	4.82 [24]	4.55 [25]	5.86 [26]
8	Total energy saved based on rebate amount	Million Units	2,380	1,868	1,098
9	Average demand reduction (24 hours and 365 days of operation)	MW	272	213	125
10	Percentage of energy savings compared to annual electricity consumption	%	1.3%	1.3%	1.0%
11	Weighted average carbon dioxide emission factor (incl. RES and Imported energy) [27]	Ton/MWh	0.711	0.711	0.711
12	Avoided CO_2 emissions for FY 22-23	Million Tons	1.692	1.328	0.780

Conclusion

In conclusion, this paper has examined the energy demand-supply gap in India and emphasized the importance of implementing energy efficiency measures to address the increasing electricity demand and inadequate power generation. It has recognized the significant role played by SERCs, DISCOMs, and SDAs at the state level in improving energy efficiency and implementing demand-side management activities. The focus has been on Maharashtra, Gujarat, and Tamil Nadu, providing an overview of their energy efficiency initiatives and incentive programs. Furthermore, the paper has clarified the expanded definition of demand side management (DSM) to encompass energy efficiency and energy conservation activities. The study has delved into the DSM activities in the mentioned states as well as by EESL and BEE, and explored different incentive programs available, including government-funded and rate-payer-funded initiatives. The introduction of a rebate-based incentive program has been proposed as a strategy to scale up energy efficiency efforts, and estimates have been made to determine the potential electricity savings achievable in the selected states. The importance of program evaluation has been discussed, highlighting its aims and necessity. The paper has also presented the various steps involved in an energy efficiency program for downstream customers, covering program planning, rebate payment, independent evaluation, impact evaluation planning, execution, reporting, and utilization of findings. Lastly, a case study has been presented, calculating the revenue generated, energy savings, and CO_2 emissions reduction for Maharashtra, Gujarat, and Tamil Nadu. Overall, this paper provides valuable insights and recommendations for advancing energy efficiency and achieving sustainable energy goals in the studied regions and all over India.

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