A Policy for Improving Efficiency of Agriculture Pump sets in India: Drivers, Barriers and Indicators

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September 2009

Climate Strategies

www.climatestrategies.org

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ISDA Project

This paper is part of the project International Support for Domestic Action (ISDA). Case studies from five developing countries assess the barriers and drivers of actions that shift individual sectors onto low-carbon growth paths. Five cross-cutting papers then explore how international financial mechanisms, technology cooperation, intellectual property aspects, and suitable monitoring and reporting arrangements can enhance the scale, scope and speed of their implementation. The project is coordinated by Karsten Neuhoff, University of Cambridge; individual reports are available at http://climatestrategies.org/our-reports/category/43.html

Acknowledgements

The author wishes to thank survey respondents at workshops in New Delhi and IIT Kanpur, and those who responded through e-mails. Author also wishes to thank Rohit Dasrapuria, Kunal and Saurabh Sharma for assistance.

Publisher

Climate Strategies 2009. For citation and reprints, please contact the publisher Climate Strategies

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Contents

List of Figures and Tables

Executive Summary

The Indian power sector provides significant opportunities for reducing energy consumption by addressing existing inefficiencies of technical, operational and economic nature. Replacement of inefficient agricultural pump sets has been identified as one of the key policy initiatives, which to date, has been limited to a few pilot projects. The policy objectives are to: replace inefficient pump sets, improve distribution grids and provide metering. Adequate readdressing of economic inefficiencies, in terms of electricity pricing, remains a long-term objective. The scalability of such a policy proposal across the country offers many challenges. The paper identifies drivers and barriers for implementation of the policy, role of international cooperation and indicators for policy implementation with international cooperation.

Policy for Adoption of Efficient Agricultural Pump Sets

The policy recommendation is to implement a joint programme for replacement of inefficient agricultural pump sets (including motor/engine and pump assemblies, piping, foot valves etc.) along with mandatory electronic metering. Such a programme should be supplemented with feeder metering and system modernization of the low tension (LT) distribution network with a High Voltage Distribution System (HVDS). The distribution companies (discoms) should also undertake separation of rural feeders with partial support from Restructured Accelerated Power Development and Reforms Programme (R-APDRP).

While a number of pilot projects have been undertaken and are proposed to replace inefficient pumps, the task of replacing about 16 million pumps presents financial, implementation, political as well as institutional challenges. Stakeholders perspective plays an important role in understanding and overcoming such challenges. A summary of the outcome from stakeholder surveys is presented below.

Drivers and Key Stakeholders:

The most important drivers that support implementation of the suggested policy are identified as,

(i) Overall energy saving; (ii) Reduced pressure on groundwater reservoirs;
(iii) Ability to manage tariff subsidy; (iv) Transparency and accountability;
(v) Facilitate appropriate tariff design

State governments are identified as the most important actors, followed by the distribution companies, central government and regulatory institutions.

Barriers:

The most critical barriers for implementing this policy are ranked below:

(i) Financing; (ii) Policy Implementation; (iii) Institutional/political;
(iv) Project Operation; (v) Monitoring; (vi) Technical

The higher price of efficient pumps coupled with the existence of the flat tariff, which is not reflective of electricity consumption, leads farmers to buy cheaper but inefficient pumps Clearly, financing is the most important barrier identified for implementing the policy.

Effective Policy Implementation

For effective implementation, replacement of inefficient pump sets should be supplemented with metering the electricity supply. As a long-term policy objective, it is envisioned that supply to agricultural consumers would be based on metered tariffs.

Given the political sensitivities, such an objective can be achieved by creating awareness, providing incentives and through a political consensus.

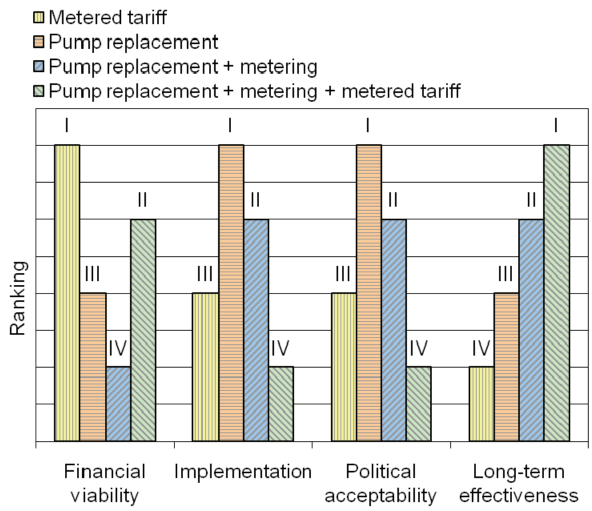

Figure: Effective Policy Implementation

International Cooperation

The role of international cooperation is highlighted for financial assistance as well as capacity building. However, it is noted that such cooperation often did not deliver much in terms of technology transfer. Three important areas identified for international cooperation are financial support, technology cooperation and capacity building (left figure).

It is noted that international cooperation, especially in the form of financial support and capacity building, has been effective, and involvement of multilateral/bilateral agencies seem to be an effectively delivery mechanism for such support (right figure). Programmes supported through international cooperation yield results when financial transfers are linked to achievement of milestones.

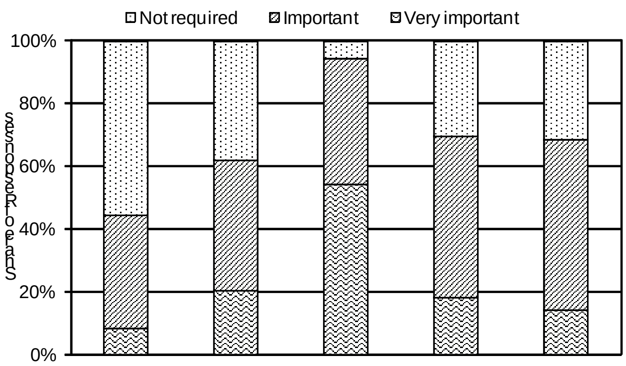

Figure. Need for international cooperation

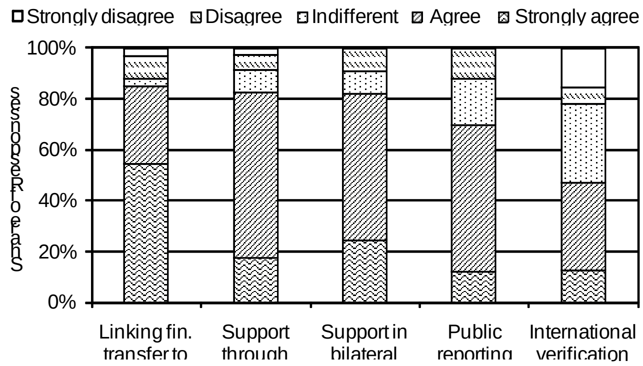

Figure: Components of international cooperation that enhance policy success

Policy Indicators

Indicators are useful for monitoring progress and have been widely used in the power sector for setting targets, quality monitoring, tariff fixation as well as for programme implementation. The Accelerated Power Development and Reforms Programme (APDRP) and, now, Restructured Accelerated Power Development and Reforms Programme (R-APDRP) present a good example of how indicators are used for designing investment programmes and providing financial incentives for improvement in the performance of distribution segments across states in the country. The Aggregate Technical and Commercial losses (AT&C) is one of the key indicators used in the R-APDRP.

Program initiation	**Deployment of efficient pumps**	**Appropriate tariff**
• Policies by SERCs • Survey of pump sets • Order issued by executive/state utilities • Policy / programme announcement by central/state govts. • Metering of pump sets, a pre-requisite for any progress	• Policies by SERCs • Monitoring the sale of pumps • Decrease in consumptions at rural feeders • load reduction, pf improvement • no. of pumps deployed • variation in demand, system stability, reduction of losses • Number of of efficient pumps • Share of efficient pumps • Changes is consumption pattern once metering is done	• Policies by SERCs • Government policy guidelines • Reduction in Govt. subsidy • Improvement in revenue • Regulatory orders for agricultural tariff • Appropriate regulations • Reduction in gap between cost to serve and tariff • Reduction of cross subsidy to comply with tariff policy

Table: Suggested key indicators to measure progress of policy implementation

1. Introduction

India is currently following a development path which aims to remove income and energy poverty of millions of households. As a result, energy requirements of the country are expected to rise. While India's energy intensity is on a decline due to structural changes in the economy and improvement in energy efficiency, overall energy requirements would grow due to growth in economic activity. For the power sector alone, the generation capacity should reach 8,00,000 MW by 2031-32, nearly a five-fold rise from the current levels (GOI, 2006). The Indian power sector offers a lot of scope to improve on existing efficiencies in generation, distribution and utilization of electricity. The resultant savings in fossil fuel consumption would translate to a large potential for reductions in associated carbon emissions.

The per capita electricity consumption in India is recorded to be 704.2 kWh in 2007-08. This is quite low as compared to the that recorded in 2006 for China (2041), high income OECD countries (9774), high income countries (9675) and the world average (2751) (World Bank, 2009). A large proportion of the Indian population continues to face income as well as energy poverty. In the future, electricity consumption per capita is likely to rise to meet the basis needs of those not served with electricity. Furthermore, increasing economic activity would place a greater demand for energy resources. In the past, investment in capacity expansion, extension of the distribution network and end-use appliances was based on least cost. This was often at the expense of energy efficiency. This approach was partly influenced by a lack of financial resources, but also by a lack of institutional capacity and absence of incentives in electricity pricing. Although significant progress is being made to introduce efficient technology and to improve operational performance in the power sector, efforts are limited due to financial scarcity as well as institutional constraints (Singh, 2009). The pricing anomalies in the power sector have been addressed in general by the SERCs to a varying degree. However, political compulsions continue to shield subsidized tariff for agricultural consumers across the country.

Energy scarcity, along with the local and global environmental impacts of energy use emphasise the need to speedily address inefficiencies in the power sector. However, numerous barriers including financial, technical as well as institutional exist and which impede the achievement of this objective. Singh (2009) discusses opportunities for efficiency improvements in the power sector and identifies the following three climate co-benefit policies; (i) adoption of efficient agricultural pump sets. (ii) modernization of the low tension (LT) distribution network to High Voltage Distribution System (HVDS) and (iii) adoption of clean and efficient coal-based generation technology. In spite of the known benefits of such policies, the progress thereof is rather limited, suggesting that the above mentioned barriers are hampering policy implementation. This paper attempts to identify the challenges in implementing a policy for nationwide programme to adopt efficient agricultural pump sets. Due to the presence of technical as well economic efficiencies associated with the policy, this exercise would offer a wider perspective amongst the three policies[1].

India adopted a National Action Plan for Climate Change (NAPCC) last year. It proposed eight national missions with climate related benefits including a National Mission on Enhanced Energy Efficiency (NME3) which has recently been approved (in-principle) by the Indian Prime Minister. Apart from this, the Bureau of Energy Efficiency (BEE) has initiated large pilot projects under the Agricultural Demand Side Management (AgDSM) programme. This aims to reduce electricity consumption for irrigation by enhancing the efficiency of pump sets. This is discussed further in the next section.

The main objective of this paper is to assess stakeholders' perspectives, through a survey, on implementing a nation-wide policy for adoption of efficient agriculture pumps. This

[1] Further, the policy related to adoption of efficient agricultural pump sets also entails HVDS investment as a prerequisite. This is discussed further in the next section.

would help to identify key drivers and barriers towards policy implementation. The paper proposes alternate policy combinations and assesses their viability as well. In addition, appropriate indicators are identified to 'measure' progress towards policy implementation.

The next section discusses a policy for introduction of efficient agricultural pump sets, including its private and social benefits. Section three presents a historical context and some of the recent policy developments. It also outlines the methodological approach of the paper. An analysis of the stakeholder survey is presented in sections four to six. A discussion on the drivers and barriers are presented in section four. Perspectives with respect to international cooperation are presented in section five. Section six outlines the need for indicators for managing policy implementation and identifies suitable indicators. Conclusions and recommendations are outlined in the final section.

2. Policy for Adoption of Efficient Agricultural Pump Sets

2.1 Policy Description

The policy recommendation is to implement a joint programme for replacement of inefficient agricultural pump sets (including motor/engine and pump assemblies, piping, foot valves etc.) along with mandatory electronic metering of their electrical connections. Such a program should be supplemented with feeder metering and system modernization of the low tension (LT) distribution network with a High Voltage Distribution System (HVDS). The distribution companies (discoms) should also undertake separation of rural feeders with partial support from Restructured Accelerated Power Development and Reforms Programme (R-APDRP).

Irrigation pumps used in the agriculture sector account for about 25% of electricity consumption in India. This share is reported to be 48.89% in Gujarat, 43.39% in Haryana and 42.27 % in Karnataka. Due to subsidised tariffs, agricultural consumers contribute only a little to the revenue of utilities. Farmers, who pay HP-based flat rates irrespective of their electricity use, perceive zero marginal cost for electricity use and, hence, disregard efficiency in consumption. This is reflected in purchase preference for cheap but inefficient pumps. Various pilot studies have revealed the poor level of energy efficiency of these pumps. An energy audit of electrical pump sets at four field study locations in Haryana average pump set efficiency was found to be only 21-24% (World Bank, 2001). The study also found that only 2% of the pumps surveyed had efficiency levels above 40%. Phadke et al. (2005) find that a DSM program for replacing ineffieicnt agricultural pumps in Maharashtra would be cost effective by lowering the short-run cost of electricity generation in the state. More recently, an energy audit of a sample of pump sets at Doddaballapur Taluk of Bangalore Rural District in Karnataka was conducted under the Water and Energy Nexus (WENEXA) Project of the USAID. The study revealed that 91 per cent pumps were operating at the efficiency of less than 30 per cent (Oza, 2007).

Subsidised tariffs for agriculture and domestic consumers are supported partly by budget subsidies from respective state governments. In 2007-08, this was estimated to be Rs. 141.6 billion (GOI, 2008). Aaprt from this, the SERCs continue to rely on cross-subsidisation of tariffs by charging higher tariffs from industrial and commercial consumers to support lower tariffs for agriculture and domestic consumers. Flat pricing of electricity and unmetered supply continues to shield inefficiency in consumption and obscures operational efficiency of utilities. A policy to enhance efficiency of pump sets, to meter such consumption and to price electricity efficiently would have wider implications for the sector and beyond. A reduction in subsidy requirement for the power sector would allow state governments to channel the funds to other social sectors including education, primary health and rural infrastructure. In this context, Singh (2009) proposed a national programme for adoption of efficient pumps for agricultural use to moderate the impact of above mentioned institutional inefficiencies.

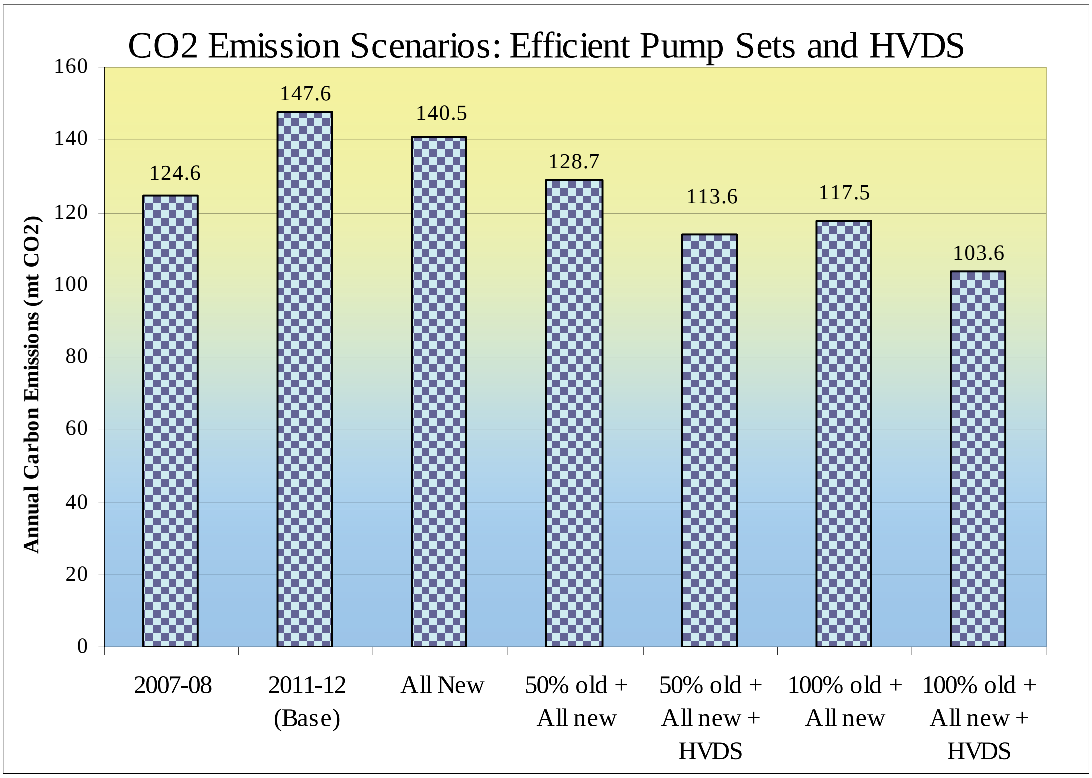

Figure 1: Scenarios for CO_2 Emissions with Efficient Pumps and HVDS[2] (So: Singh, 2009)

We constructed alternate policy scenarios for varying degree of adoption of efficient pump sets by farmers. It is assumed that number of agricultural pump sets would grow to 20 million by 2011-12. In efficient scenarios, all new pump sets are expected to be efficient, and hence require less number of hours of operation, and have 10% lower rated output. Similar is the case for all pump set replacements. The transmission and distribution (T & D) losses are expected to fall from 32.25% in 2007-08 to 25% by 2011-12. Figure 1 provides estimate of reduction in CO_2 emissions under alternate scenarios for the year 2011-12 for adoption of efficient agricultural pump sets and HVDS. In a conservative scenario with little penetration of efficient pumps, it was estimated that about 5% reduction in carbon emissions can be achieved. In the case of an aggressive pump replacement scenario, a reduction in carbon emissions of up to 30% can be achieved.

Apart from reduction in electricity consumption and hence the use of fossil fuels in the sector, there are other private and social benefits as well (Table 1). The private benefits for the farmers include better quality of power and hence lower cost of maintenance. In the long-run, better distribution grid and improved power scenario would enhance reliability of power supply. This may help farmers to make judicious use of water based on requirement rather than based on availability of power as practiced currently. The existing experience from pilot programmes suggests that post-replacement water discharge from the pumps improves thus requiring lesser hours of pump usage (Figure 2)[3].

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[2] 'All new' scenario envisages only new agricultural connections to be fitted with efficient pumps. The '50% old + All new' scenario additionally envisages that 50% of the existing pumps would be replaced by efficient ones, and so on. The scenarios with HVDS envisage conversion of the existing LT distribution grid to HVDS.

[3] Based on a sample of 79 pumps replaced in Mansa, Vijapur and Kankrej in Gujarat under a scheme of Gujarat Energy Development Agency (GEDA).

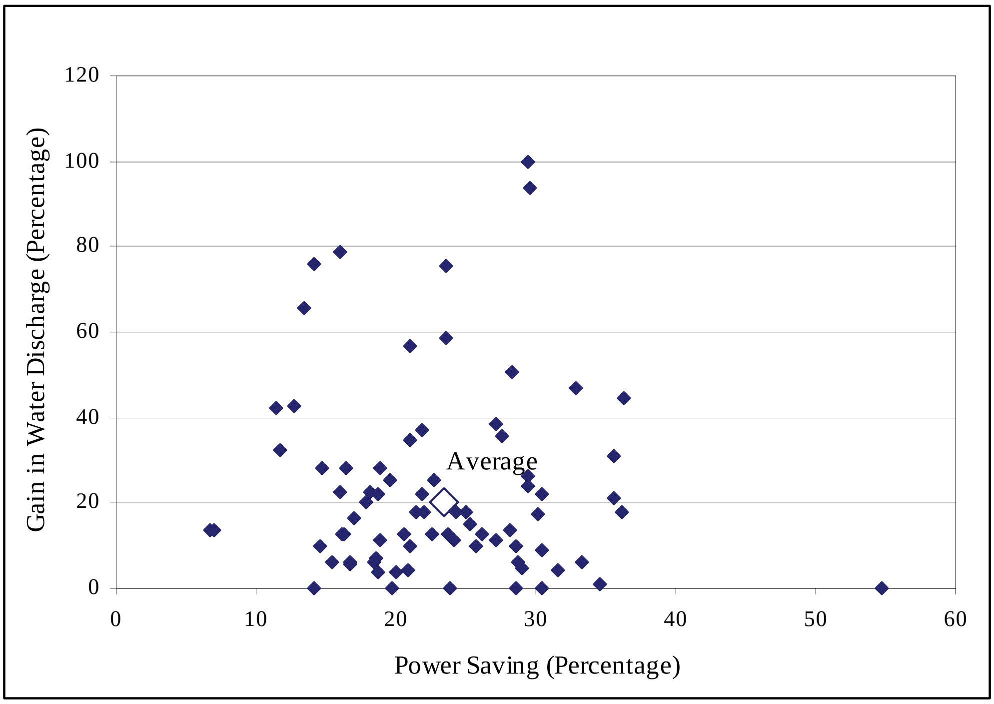

Figure 2: Performance improvement after replacement of inefficient pumps in Gujarat

There are multiple benefits for the power sector utilities as well. A lower demand for power from the agriculture sector would improve consumption profile towards better paying customers and, hence, would improve revenue realization per unit of electricity. Agricultural loads are rather spread out and hence incur higher technical losses. A change in consumption pattern away from agriculture could lower overall technical losses for the distribution utilities. It is often argued that due to the absence of metering, part of T & D losses are often camouflaged as consumption in the agriculture sector. Better metering and energy accounting would certainly help in bringing more transparency in the system. These are expected to improve operational as well as financial performance of distribution utilities. In the long-run, these changes would provide a conducive environment for efficiently pricing the electricity in a manner which provides incentive for energy conservation. A lower demand for electricity would necessitate lower investment for generation capacity addition in the sector in the long-run.

Benefits to:	Short-term	Medium-term	Long-term
Farmers	• Improved water discharge • Better quality of power	• Low cost of maintenance	• Reliable power supply
Utilities	• Better revenue realization per unit • Lower network losses • Better transparency and accountability	• Reduced investment in generation capacity • Better operational performance • Better financial performance	• Efficient pricing of electricity
Society (State/India)	• Lower budget subsidy • Lower cross-subsidy • Lower peak and energy shortages	• Reduced peak and energy shortages • Conservation of ground water	• Economic efficiency in pricing • Rational use of resources • Institutional framework for similar policies in the future
Society (Global)	*	• Lower carbon emissions	• Lower impact on climate change • Lower pressure on energy resources

Note: * - Due to persistent electricity shortages in India, any short-term savings in electricity consumption is expected to be consumed elsewhere in the system and hence may not result in immediate carbon savings.

Table 1: Private and social benefits from adoption of efficient pump sets

Stakeholders' perspectives are sought through a survey. A questionnaire was designed to ascertain key stakeholders' responses on policy drivers and barriers. It was administered to participants at workshops in New Delhi, and at the IIT Kanpur. Sections three to six analyse the outcomes of this survey based on inputs from forty one respondents.

2.2 Implementing a Nationwide Agricultural Pump Set Replacement Programme: Institutional Capacity and Financial Support

By the 31st March 2008, around 15.47 million pump sets have been energized in the country (CEA, 2008). This increased to 16 million by the 30th June 2009 (CEA, 2009). This number is expected to grow further with the expansion of the rural electrification programme. Furthermore, thousands of diesel-based agricultural pump sets could also be replaced with electrical ones, if there is an improvement in reliability of power supply to rural areas[4]. Carbon savings from this exercise, though not enumerated, could be substantial.

The inefficiency of agricultural pumping has been recognized for a long time and various pilot level efforts have been undertaken to address it (Table 2). These include simple rectifications involving piping and valve systems to replacement of the pump set.

[4] The efficiency of such diesel irrigation pumps is abysmal by itself. Bom et al. (2001) report that there were 6.5 million diesel irrigation pumps in India in mid 80s. The authors found during field studies that suitable modifications can reduce fuel consumption by 25 - 50%.

S. No.	Pilot & Place	Year	No of Pumps	Implementing Agency	Funding Agency
1	Adoption of efficient mono-block pumps, (Gujarat)	1988-1993	521	Institute of Cooperative Management, Ahmedabad	Ministry of Energy / Farmers[5]
2	Replacement of Pump sets, (Warrangal AP)	1993-96		NEDCAP & APSEB	JBIC
3	Replacement of Pipe & foot valve, (Chittoor AP)	1987-90	6000	NEDCAP & APSEB	DFID
4	Single-phase HVDS and pumps, (Nalgonda AP[6])	1998-00	1641	APTRANSCo	DFID
5	DSM Pump replacement project, (Madhya Pradesh)	2002-03	50	Kirloskar	CIDA
6	Pump replacement in five Talukas (Gujarat)	2007-08		GEDA	GEDA (50% subsidy)

Table 2: Agriculture pump set energy efficiency programmes (Source: Patel & Pandey 1993, Goyal 2009, NIRD 2002)

The Bureau of Energy Efficiency (BEE)[7] has recently focused its attention on improving the inefficiency of agricultural pump set and has initiated a few pilot projects across the country under the Agricultural Demand Side Management (AgDSM) programme. Under this programme, the BEE is providing resources to create a shelf of bankable Detailed Project Reports (DPRs) in the agricultural sector specifically to replace inefficient irrigation pumps. In Phase I of the programme, projects will be implemented in the states of Maharashtra, Gujarat, Rajasthan, Haryana and Punjab. The pilot projects are to be implemented by Energy Service Companies (ESCOs). USAID has also initiated a similar programme, under its Water and Energy Nexus Programme (WENEXA), to replace pumps in the state of Karnataka.

S. No.	State	Number of feeders	Number of pumps connected	Implementing Agency	Funding Agency
1	Maharashtra	4	2215	BEE/ESCO	ESCO
2	Rajasthan	13	1949	BEE/ESCO	ESCO
3	Gujarat	06	1607	BEE/ESCO	ESCO
4	Punjab	06	2081	BEE/ESCO	ESCO
5	Haryana	15	1994	BEE/ESCO	ESCO
6	Karnataka	2	601	USAID/ESCO	ESCO

Table 3: Proposed and ongoing agricultural DSM Pilot Projects (Source: BEE 2009a, 2009b, Oza 2007, Britton et al., 2006)

[5] About 34.5% of the cost of new pumps was subsidised, and the rest was contributed by farmers.

[6] This includes conversion of existing 3-phase low voltage distribution system into single-phase HVDS in 16 villages and replacement of 3,216 3-phase pump sets with single-phase ones. By September 2000, when the scheme was prematurely closed, 1,641 pump sets in 11 villages were converted to HVDS (NIRD, 2002).

[7] The Bureau of Energy Efficiency (BEE) was setup in 2002 under the Energy Conservation Act 2001 to promote energy efficiency.

The Agricultural DSM pilot project was initiated in the Solapur District, Maharashtra on the 1st February 2009. This involves energy audit of all the pumps in the project area to measure their efficiency. After the energy audit, existing pumps and motors would be replaced with new BEE star-labeled ones. Farmers will receive BEE star-labeled pump sets free of cost. Since such projects are being implemented by ESCOs, no initial investment would be required from the utility.

To ensure that there is a credible system for estimating baselines and to measure improvement in performance, the boundary line of the target area needs to be clearly defined, with appropriate metering. To ensure this, pilot programme are only being implemented in areas where feeders for agricultural supplies in rural areas have been separated and the distribution network has been upgraded to High Voltage Distribution System (HVDS). Metering on HVDS has been introduced in most places except in the state of Punjab, where there is limited metering.

The ongoing efforts to replace inefficient agricultural pump sets are of pilot nature and cover a very small population of pumps. An ongoing programme for pump set replacement in Gujarat is purely on voluntary basis wherein farmers, local distribution utility and a state-wide power utility contribute equally towards cost of new and efficient pumps. The AgDSM programme initiated by the BEE is based on Energy Service Company (ESCO) model, a novel concept in the Indian context. Implementation such programmes is handled locally by the distribution companies and the respective energy development agencies in the state.

3. Drivers and Barriers

3.1 Drivers and Key Stakeholders: Agricultural Pump Set Replacement

Identification of drivers a policy implementation empowers the policy makers as well as the implementing agencies to commit resources. The importance of key drivers for implementing a nation-wide policy for pump set replacement would also assist in identifying benefits to various stakeholders and thus seek their cooperation and commitment. It is often noted that a lack of institutional capacity has resulted in failure of various public programmes both within and outside the energy sector. The most important drivers that support implementation of the suggested policy are identified as:

(i) Energy savings
(ii) Reduced pressure on groundwater reservoirs
(iii) Ability to manage tariff subsidy
(iv) Enhanced transparency and accounting of energy consumption
(v) Facilitation of appropriate tariff design

It is important to note that benefits of the policy go beyond the power sector and has other environmentally benign outcomes, like by easing pressure on groundwater reservoirs. Due to lack of consumer metering and energy accounting, system losses have been camouflaged as high consumption in the agricultural sector (Singh, 2006). Improved transparency and energy accounting would not only plug revenue leakages, but may also reduce the tariff subsidies from state governments.

The respondents to the survey identify the respective state governments as the most important actors for the implementation of this policy. This was followed by the distribution companies, central government and regulatory institutions. Furthermore, the respondents also identified a role for associated ESCOs / implementing agencies, who would undertake projects for replacement of inefficient pump sets. Given the crucial role to be played by stale level entities, a clear recommendation would be to strengthen institutional capacity with state-level agencies to successfully implement such a programme.

3.2 Barriers: Agricultural Pump Set Replacement

The technological solutions for choosing a low-carbon trajectory exist and are being adopted across the world to varying degree of scope and scale. However, the relative degree of options of such solutions suggests presence of certain barriers that need to be identified and addressed. Sathaye et al. (2006) assent that most of the commercially available energy efficient technologies are cost effective on their own. However, adoption of such technological solutions in developing countries like India is often hampered by institutional, procedural, and process barriers. The authors suggest that public policy and programs to implement DSM programmes could work with market mechanisms to provide a sound business proposition for investors.

Identification of key barriers in policy implementation would help take effective advance measures to overcome such barriers. This would also require sprucing the up institutional capacity with key stakeholders to ensure successful policy implementation. Singh et al. (2006) identify barriers to adoption of clean and efficient technologies in the for power generation in India: These technologies include Integrated Gasification Combined Cycle Coal technology (IGCC), Pulverised Fluidised Bed Combustion (PFBC) and Biomass Integrated Gasification Combined Cycle technology (BIGCC). Apart from high capital cost, lack of domestic technological capacity and institutional capacity emerged out to be key barriers.

The respondents to the survey were asked to rank barriers to policy implementation. The most critical barriers are ranked below:

- (i) Financial
- (ii) Policy Implementation
- (iii) Institutional/political
- (iv) Project Operation
- (v) Monitoring
- (vi) Technical

The technical aspects related to the replacement of inefficient pump sets are relatively well known. Efficient pumps are widely available but at a much higher cost. The higher price of efficient pumps and HP-based flat electricity tariff leads farmers to buy cheaper but inefficient pumps. This highlights financing to be the most important barrier for implementing the policy. Due to the flat tariff, farmers do not perceive a value for incremental cost of inefficient pumps. Replacing nearly 20 million agricultural pumps is a mammoth task. Only small-scale pilot schemes have been attempted so far (Tables 2 and 3). Consumer data on load connected is far from perfect and needs verification on ground. Differences in geological conditions, agricultural practices, and the prevailing local socio-economic and political conditions would make it a challenging task to centrally design and implement a national-level programme. This would require flexibility with respect to agro-climatic zones, licensees' jurisdictions, modes of financing and agencies for implementation. Apart from the above factors, the geographical spread for project implementation also poses a challenge for project operation and monitoring. The approach to implementation should account for potential leakages due to incomplete coverage and to avoid recycling of old pumps.

4. Viability of Policy Combinations and Effective Implementation

The replacement of inefficient pump sets with efficient ones should be supplemented with metering the electricity supply to agricultural consumers. As a long-term policy objective, it is envisioned that the supply to agricultural consumers would be based on a metered tariff; a policy being supported by State Electricity Regulatory Commissions (SERCs). Given the political sensitivities, such an objective could be achieved by: creating awareness, providing incentives and through a political consensus. The viability of implementing different combinations of policies (pump replacement, metering and metered tariff) was ascertained and ranked by survey respondents in terms of financial viability, feasibility of implementation, political acceptability and long-tern effectiveness (Figure 3).

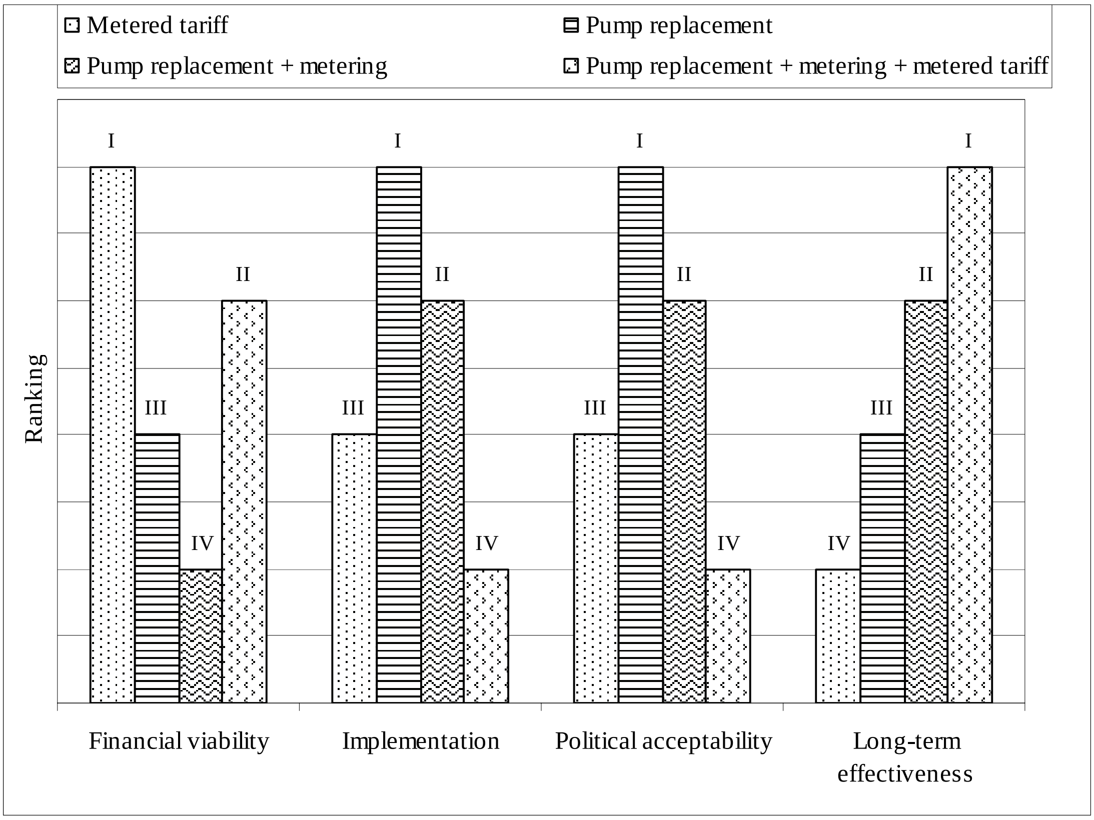

Figure 3: Viability of policy combinations (Ranking)

In terms of financial viability, implementing the metered tariff (with metering) was deemed to be the most viable financial as this can be implemented by low investment in metering agricultural connections. If implemented effectively, with an appropriate tariff design, it would incentivise the choice of more efficient pumps in the long-run. The current level of metering of agricultural consumers remains low across states. Due to political sensitivities, the enthusiasm for implementing more metered tariffs also remains low. In terms of ease of implementation and political acceptability, the 'replacement of pumps' appears to be a leading choice. The long-term effectiveness in term of energy saving and performance improvement of the power sector can emerge if a metered tariff could be implemented along with pump replacement and metering. Understandably, the respondents also rank this policy combination as the highest in terms of long-term effectiveness. Policy interventions with appropriate financial support should be aimed at achieving this objective in the long-run.

5. Policies for Agricultural Pump Set Replacement: International Cooperation

A lack of financial resources and technological and institutional capacity has often been addressed through various multilateral and bilateral agencies in implementing various programmes in developing countries. International cooperation has played an important role in the Indian power sector. The most noteworthy example of this being the Indo-German collaboration involving GTZ and the Bureau of Energy Efficiency (BEE). The former provided technical support for setting this local institutional responsible for energy conservation efforts in the country.

Given the historical role played by various multilateral and bilateral agencies, we asked inputs from stakeholders about the role of such cooperation. Three important areas identified for international cooperation are financial support, technology cooperation and capacity building (Figure 4). It is noted that international cooperation especially in the form of financial support and capacity building have historically been very effective, particularly when multilateral/bilateral agencies are used as a delivery mechanism for such support (Figure 5). However, it can be noted that international cooperation has been less effective in delivering technology transfer.

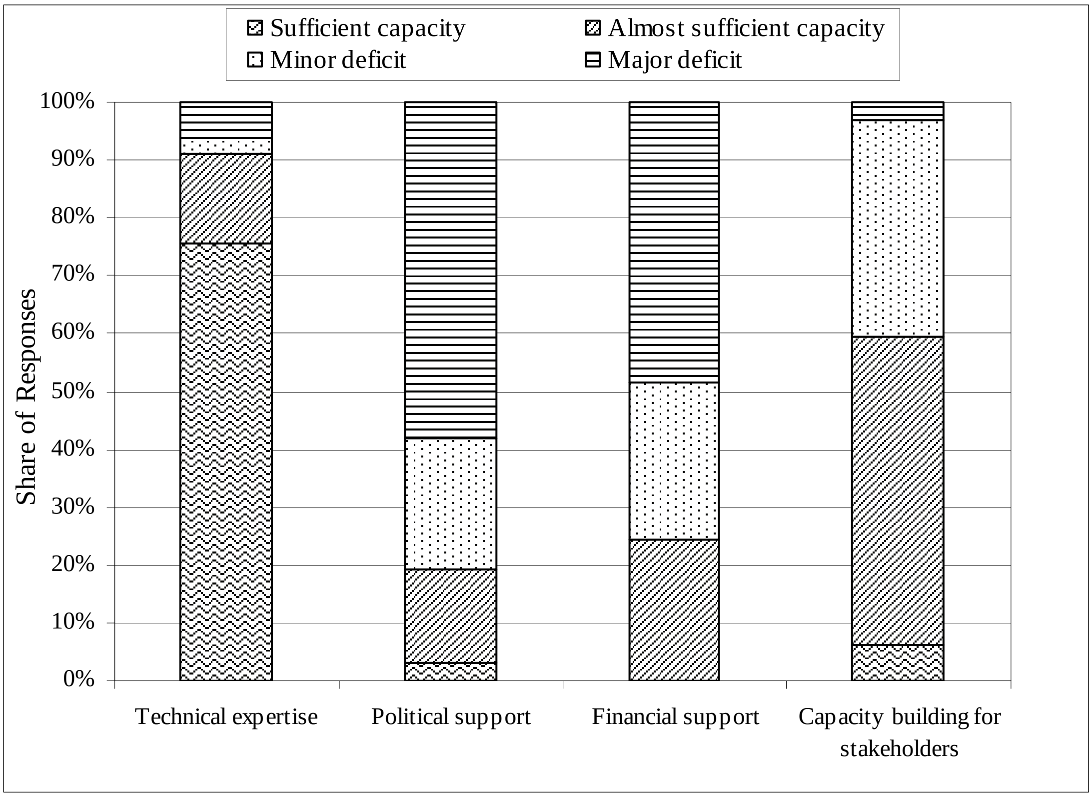

Figure 3: Domestic capacity for implementing a policy on agricultural pump set replacement

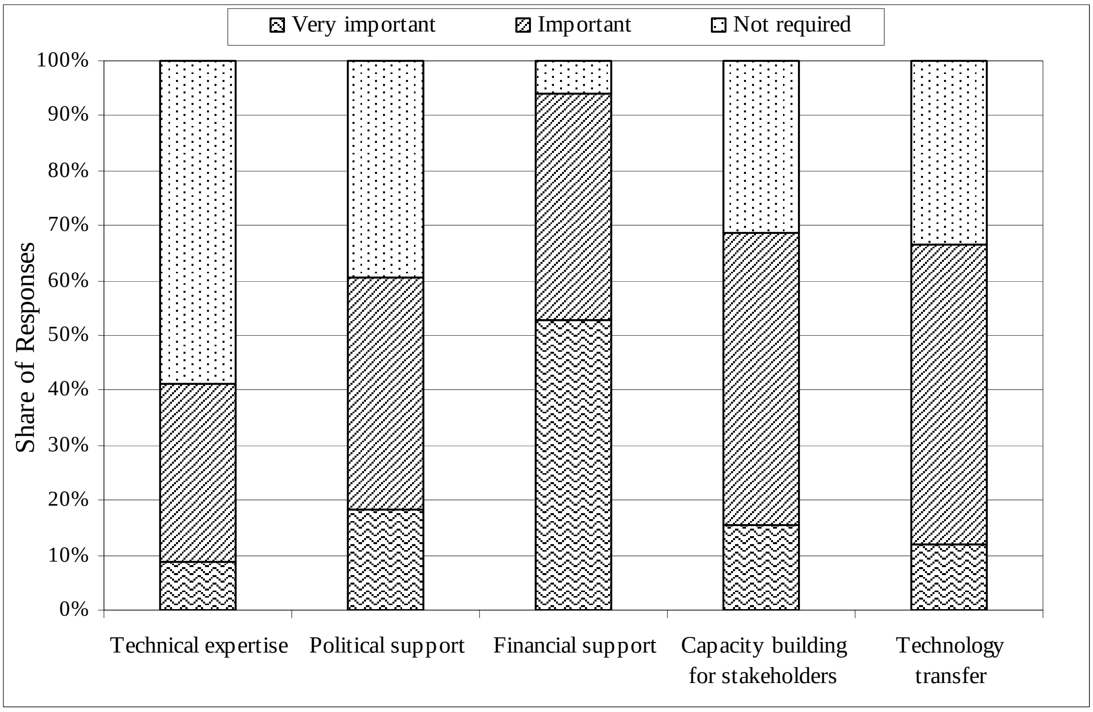

Figure 4: Need for international cooperation for implementing a policy on agricultural pump set replacement.

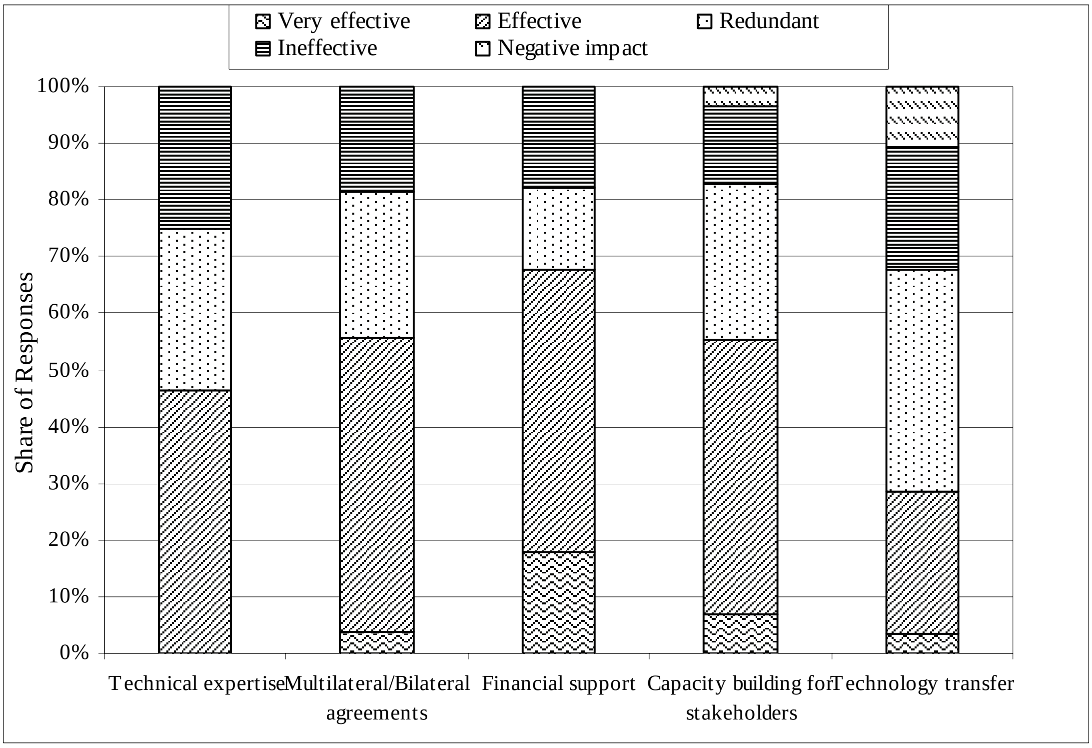

Figure 5: Experience with existing international support for similar programs

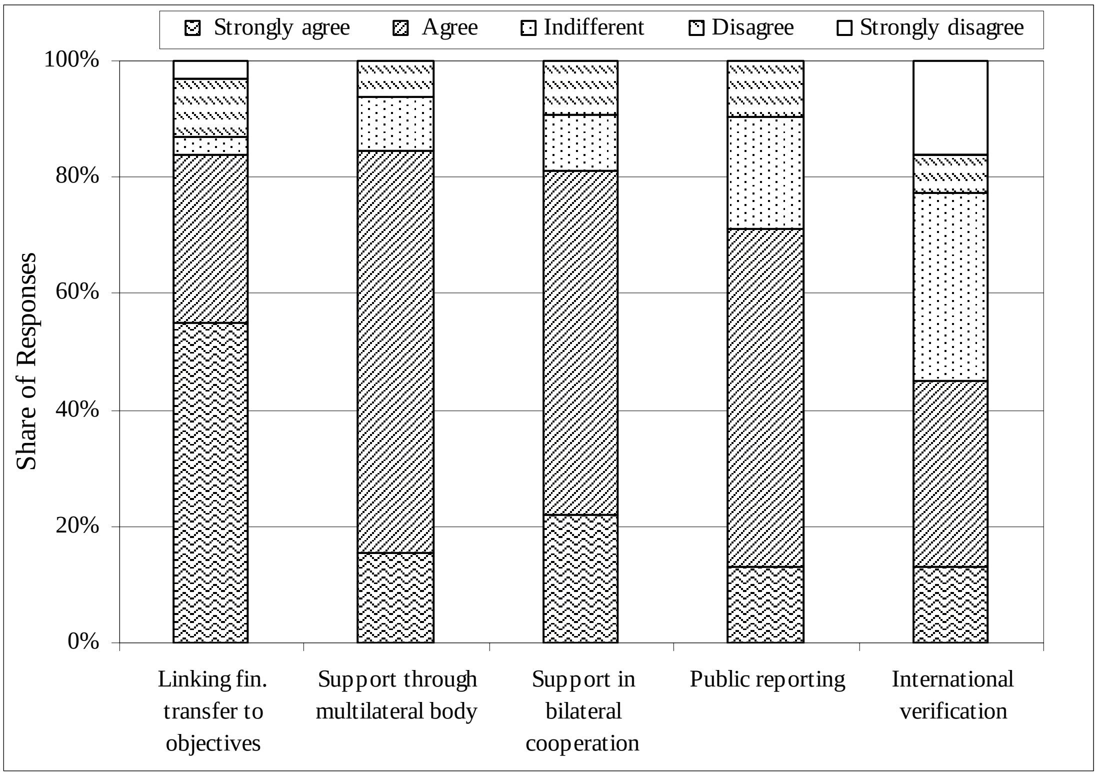

Figure 6: Components of international cooperation that enhance policy success

It is noted that programmes supported through international cooperation yield better results when financial transfers are linked to achievement of milestones (Figure 6). This is often the approach used by multilateral agencies like the World Bank and the Asian Development Bank. Survey respondents suggested that there was a limited role for international verification for implementing the policy for replacement of agricultural pump sets.

6. Policy Indicators: Agricultural Pump Set Replacement

Indicators are useful for monitoring progress and have been widely used in the power sector for setting targets, quality monitoring, tariff fixation as well as for programme implementation. The Accelerated Power Development and Reforms Programme (APDRP), and, now rechristened, Restructured Accelerated Power Development and Reforms Programme (R-APDRP) represent good examples of how indicators are used for designing investment programs and for providing financial incentives for improvements in the performance of the electricity distribution sector segments. R-APDRP is a programme implemented by the central government for assisting projects for performance improvement. The 'Aggregate Technical and Commercial losses (AT&C)' is one of the key indicators used in the R-APDRP. Privatisation of distribution utilities in Delhi was also linked to a projected reduction in the AT&C losses. The survey respondents emphasised the general importance of indicators, particularly for project or policy implementation (Figure 7).

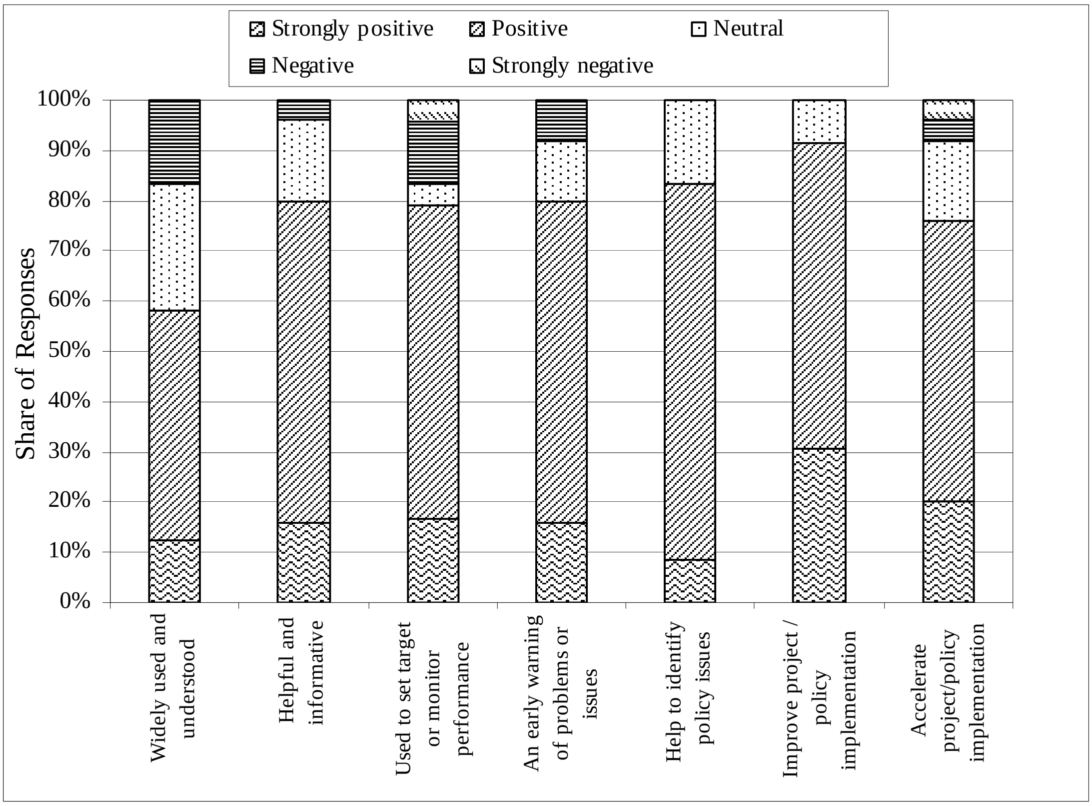

Figure 7: Role of indicators

Given the general positive feedback regarding the role of indicators for policy implementation, the next task is to develop indicators which are specifically suitable for managing implementation and measuring progress of the policy implementation. The following indicators are therefore proposed:

1	*Indicators to measure the progress of program initiation*
	• Regulations by different SERCs • Survey of pump sets • Order issued by executive/state utilities • Policy / programme announcement by central/state govts. • Metering of pump sets, a pre-requisite for any progress
2	*Indicators to measure progress of deployment of pumps*
	• Monitoring the sale of pumps • Decrease of electricity consumption in rural feeders • Load reduction, power factor improvement • Change in demand, improvement in system stability and reduction in losses • No. of efficient pumps deployed • Share of efficient pumps • Changes is consumption pattern once metering is done
3	*Indicators to measure progress towards appropriate tariff*
	• Government policy guidelines • Reduction in subsidy support required from state governments • Improvement in revenue realisation • Regulatory orders for agricultural tariff • Appropriate regulations by SERCs • Change in tariff charged from agricultural consumer • Reduction in gap between cost to serve and tariff • Reduction of cross subsidy to comply with tariff policy

Table 2: Suggested indicators to measure the progress of policy implementation for agricultural pump set replacement

From among the above indicators suggested by the stakeholders in the survey, we find that a policy by central or state governments, or regulations by the State Electricity Regulatory Commissions could serve as an important indicator that would signify a level of commitment and vision to widen replacement of inefficient pump sets. A variety of alternative indicators for progress monitoring are suggested by respondents. Amongst these, number of efficient pumps deployed, share of efficient pumps could be the more direct indicators. However, a decrease in electricity consumption in rural feeders would provide a measure of medium-term effectiveness of the programme. In the long-run, reduction in gap between cost to serve and tariff charged to agricultural consumers would help measure the economic effectiveness of the policy.

The central public sector utilities (CPSUs) have been engaged to implement the flagship rural electrification programme, the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), in the country. This mode was adopted to partly overcome the lack of institutional capacity with local distribution utilities in implementing such programs. Given the prevailing experience of CPSUs in the rural areas, responsibility for AgDSM programmes can be entrusted with such central-level institutions, especially where a majority of financial support is provided by central agencies or through international cooperation.

6.1 Responsibility for Data Collection and Verification

Given the nature of the policy, the central government (Ministry of Power) and associated agencies seem to favoured by respondents for collection of relevant information for measuring and monitoring policy implementation. Apart from this, generation companies, pollution control boards, Ministry of Heavy Industries and the SERCs could also collect such information. Verification of the information could be entrusted to independent third parties such as the Central Electricity Authority (CEA), Bureau of Energy Efficiency (BEE) or the sector regulators.

	Responsibility for data collection	**Responsibility for verification**
1	*For indicators to measure progress of program initiation*	
	• Discoms • Pump manufacturers • Energy auditor firm • Energy Service Company (ESCO) • Independent third parties • An agency appointed by central government. • NGOs • Implementing agency • State government. • Bureau of Energy Efficiency (BEE)	• SERCs • Discoms • State/central credit agencies • National Council for Applied Economic Research (NCAER) • Rural Electrification Corporation (REC) • Independent third parties • Central government. • Regulator through 3rd party • Institution giving aid through its advisors / • Rural Electrification Corporation (REC) / BEE
2	*For indicators to measure progress of deployment of pumps*	
	• Discoms • Pump manufacturers • Pump manufacturers' Association • Sales Tax Dept. • Energy Service Company (ESCO) • Independent third parties • Agency appointed by central government. • NGOs • Implementing agency • State government. • BEE	• Central government. • Regulator through third parties • Institution giving aid • Consultants appointed by BEE • Central public sector utilities like NTPC / PGCIL • Independent third party • Discoms • SERCs
3	*For indicators to measure progress towards appropriate tariff*	
	• Discoms • SERCs • Energy Service Company (ESCO) • Independent third parties • NGOs • Ministry of Power • State government. • Bureau of Energy Efficiency • Forum of Regulators (FOR)	• Discoms • SERCs • Independent third parties • NGOs • Central / State Governments • SERCs through third party • Forum of Regulators (FOR) • Central Electricity Authority (CEA)

Table 3: Responsibility for Data Collection and Verification

It can be noted that the institutional responsibility to provide and verify appropriate information / data to quantify indicators can not be entrusted to multiple organisations. Local energy agencies, distribution utilities supervised by the SERCs, and the BEE could provide information on progress of deployment of efficient pumps. These could be verified by independent organisations including central government organisations.

7. Conclusions

A national-wide policy for replacement of inefficient agricultural pumps and conversion of LT distribution grid to HVDS would bring significant dividends at local as well as global level. At the local level it would help the Indian power sector by helping to curb network losses. In addition, the increased accountability through improved distribution networks and metering would reduce the non-technical loss, which is a euphemism for theft of electricity. Thee policy also assumes greater significance because of its role in reducing subsidy burden for the state governments.

The perspectives from stakeholders helped us to identify key drivers and barriers for policy implementation. The paper also explores the role and scope of international cooperation for policy implementation. Furthermore, appropriate indicators are suggested to 'measure' the progress of policy implementation. The study suggests that the opportunities for adoption of energy efficient technologies in developing countries are often forgone not only because of financial constraints but also due to lack of institutional capacity.

A new policy initiative has recently been launched by the Indian government under its National Action Plan on Climate Change (NAPCC). This outlines eight national missions as adaptive / mitigation policy options to address climate change including a National Mission on Enhanced Energy Efficiency (NME3). The NME3 offers opportunities for accelerated implementation of the policy for replacement of inefficient pump sets at the national level.

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Climate Strategies is grateful for funding from the government of Australia, Agence de l'environnement et de la maîtrise de l'énergie (ADEME) in France, Ministry of Foreign Affairs (MFA) in Norway, Swedish Energy Agency, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) in Germany, Department for Environment, Food and Rural Affairs (DEFRA), the Office of Climate Change (OCC), Department for International Development (DFID) in the UK, The Carbon Trust in the UK, Corus Steel, Center for International Public Policy Studies (CIPPS) in Japan, European Climate Foundation (ECF), and the German Marshall Fund of the United States.