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Pumpset Energy Efficiency: Agriculture Demand Side Management Program

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Abstract

This paper is focused on sharing the results of implementing the Electrical Demand Side Management pilot project in agriculture pumping sector and explains the various drivers contributing towards electrical in-efficiencies in existing irrigation practices. The case study discussed in the paper will set up an introductory benchmark practices for diffusing energy efficiency in agriculture pumping sector.

Keywords: Agricultural Demand Side Management program, energy efficient irrigation pumpset.

Nomenclature:

1. **Agriculture Demand Side Management program**: AgDSM
2. **Star rated Energy Efficient Pumpsets**: EEPS
3. **Agriculture pilot project implementing agency**: AgIA
4. **ESCO**: Energy Service Companies
5. **MSEDCL**: Maharashtra State Electricity Department Corporation Limited.

1. Introduction

The agriculture sector contributes around 20%[1] to the GDP of India and is responsible for around 18%[2] of the country's total electricity consumption. The electricity consumption of the agricultural sector has rapidly increased over the years. The electricity consumption of the agricultural sector has increased from around 10% of the total electricity consumption in 1970 to around 18% of the total electricity consumption in 2011-12. The rapid increase in electricity consumption of the

agricultural sector is attributed to growth of rural electrification coupled with policy of below cost electricity supply to farmers.

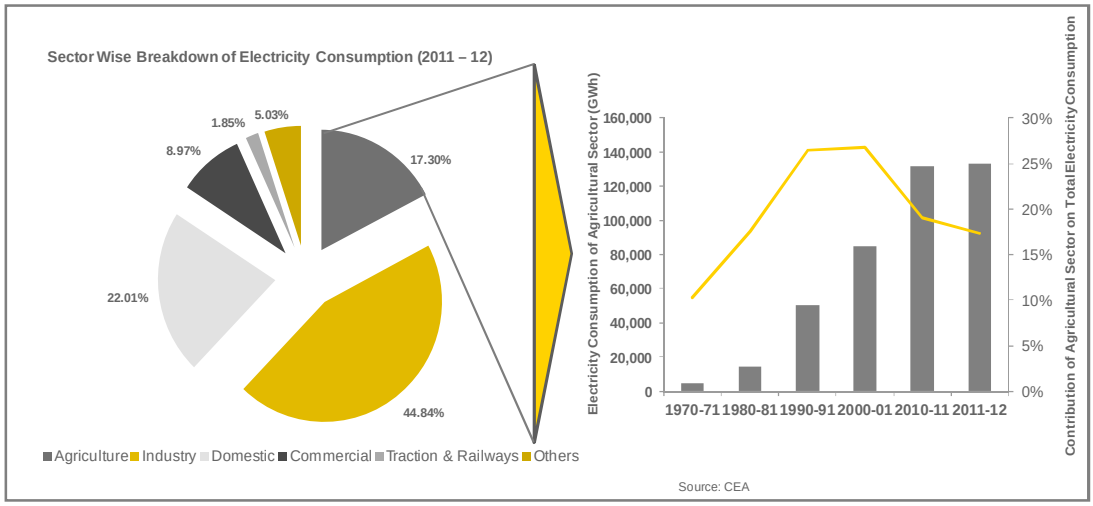

Figure 1: Agriculture Sector Electricity Consumption.

There are about 19 million pumpsets[3] presently energized in India and annual addition of .25 to .5 million pumpsets[4] are realized in this sector. Low or free electricity coupled with high inefficiencies contributes to adoption of local made in-efficient & unreliable pump sets, results in massive water exploitation and loss of several crore rupees to State governments (Rs.45,000 Cr in year 2011-12[5]) on account of free tariff subsidy provided to agriculture consumer. The average efficiency of existing in-efficient pumpsets is in the range of 25% - 30%[6] whereas efficiency range of new star rated Energy Efficient Pumpsets (EEPS) is 40% - 45%[6]. Therefore, there is a need to tap the huge energy savings potential promised in agriculture pumping sector.

2. National Agriculture Demand Side Management Program

Considering the challenge to induce the energy savings in agriculture pumping sector, during XI five year plan Bureau of Energy Efficiency, Ministry of Power initiated Agriculture Demand Side Management (AgDSM) program with the objective of reducing energy intensity of the sector through market transformation by carrying out existing pump set efficiency up gradation on Public Private Partnership (PPP) mode.

The Ag DSM scheme of BEE was initiated in the XI plan period involving eleven DISCOMs of eight states (Maharashtra, Haryana, Punjab, Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh and Karnataka) which are agriculturally intensive and account for more than 70%[3] of electricity consumption in this sector. The scheme covered about 20,000 pump sets & 11 bankable Detailed Project Reports (DPRs) were

prepared. These DPRs have been prepared to include baseline estimation, energy saving potential assessment, risk mitigation measures, cost benefit analysis etc. The overall impact of the Ag DSM scheme is as follows:

- Average of 40% saving potential has been assessed.
- 96 million kWh of electrical energy saving potential assessed.
- Energy efficiency market unlocked for investment of INR 65 Crore
- Total annual benefit of INR 25 Crore for utilities and state government assessed.
- Successful pilot projects, so that National level replication can be done for such projects and implemented across the country
- Successful internationally approved (UNFCCC) M&V methodology in place.
- Appropriate risk mitigation measures have been identified through pilot scale demonstration.

Three business models were developed to implement the detailed project reports in selected 8 states through public private partnership (PPP) mode.

a) **DISCOM Model -** The DISCOM utilizes its own Funds collected under a tariff regulation for replacement of old inefficient pumps with new higher energy efficiency pump sets and contract out repair and maintenance of pumps and certain aspects of project works to a project contractor.
b) **ESCO Model -** An ESCO which has a contract with DISCOM finances and implements the project; the ESCO would borrow the project debt and repay it from project energy saving revenues. The pump manufacturers can also participate as ESCOs in this mode of implementation.
c) **HYBRID Model -** ESCO provides part of project funds through debt & equity and sign a contract with DISCOM, whereas as the investment made by ESCO would be paid by DISCOM through LMC fund and ESCO also shares energy saving revenue with DISCOM.

3. First Agdsm Pilot Project Implementation in Solapur Circle of Maharashtra

BEE has facilitated and initiated the implementation of first Ag DSM pilot project in Solapur circle of Maharashtra where 2209 old in-efficient pump sets connected on 5 segregated feeders were replaced with star rated Energy Efficient Pump sets (EEPS) on PPP mode. This pilot project is being implemented on HYBRID business model, where an pumpset manufacturer invests in this project and replace the in-efficient pumpsets with EEPS and provide free operation and maintenance cost for installed pumpsets for the period of 5 years. The intervention would lead to lower energy supply on the feeder, and hence, could result in lower subsidy to be paid by the State Government. Based on the guaranteed savings achieved, investment made by the

ESCO in this project will be paid back by DISCOM in 5 equal annual instalments through Load Management Charges (LMC) collected by DISCOM. Also, part of the savings (30% of the savings) realized under this project, would be paid to the ESCO on an annual basis.

4. Measurement of Energy Savings

Monitoring and Verification (M&V) is the process of using measurement to reliably determine actual saving created within an individual facility/project by an energy management program. M&V activities include site surveys, metering of energy and independent variables, engineering calculations, and reporting. These activities are applied to determine energy savings depending on the characteristics of energy conservation measures (ECMs) being implemented and balancing accuracy in energy savings estimates with the cost of project implementation & conducting M&V.

In order to establish quantum of energy savings under this pilot project, third party monitoring and verification (M&V) protocol has been establish to check test the performance parameters of the old in-efficient and new installed energy efficient pumps (EEPS) to compare and establish the quantum of energy savings achieved by replacement of in-efficient pumpsets. The M&V of the total pumpsets was done at the time of replacement of total pumpsets and subsequently perform the annual sampled check testing @10% of total pumpsets installed for the period of next five years.

Based on the energy savings achieved at the time of total pumpsets installed and in subsequent years, payment to the ESCO will be made by DISCOM in equal annual installments. Outlined tasks of M&V agency:

- The M&V agency shall test all the existing pumpsets as well as the EEPS at the time of replacement.
- The baseline energy consumption and energy savings for the first six months shall be estimated based on this initial testing and average annual operating hours of 1640 hrs (deemed savings approach).
- For subsequent period of the project, a stratified random sampling technique shall be used to select the pump sets tested. Stratification criteria shall be the type and the rating of the pump sets. An estimated size of 10% of the total number of pumpsets shall be tested randomly every year.
- The sample pump sets shall be tested by the M&V agency in the presence of MSEDCL and AgIA annually for demonstrating the savings.
- The data will then be used to stipulate annual savings based on the estimate of the average operating hours per annum 1640 hrs (deemed savings approach).
- In addition to above a third party shall also undertake energy meter readings which can be verified or audited by MSEDCL.
- Baseline established in the first year (during replacement of pump sets) will not be adjusted for any change in parameters affecting the baseline. There shall not

be any adjustments / corrections (Resulting from change in parameters) made to the annual performance of the pump sets demonstrated by the AgIA.

- In the first six months of the project, performance of EEPS installed shall be demonstrated at the time of replacement where as in subsequent years performance of EEPS shall be demonstrated annually.

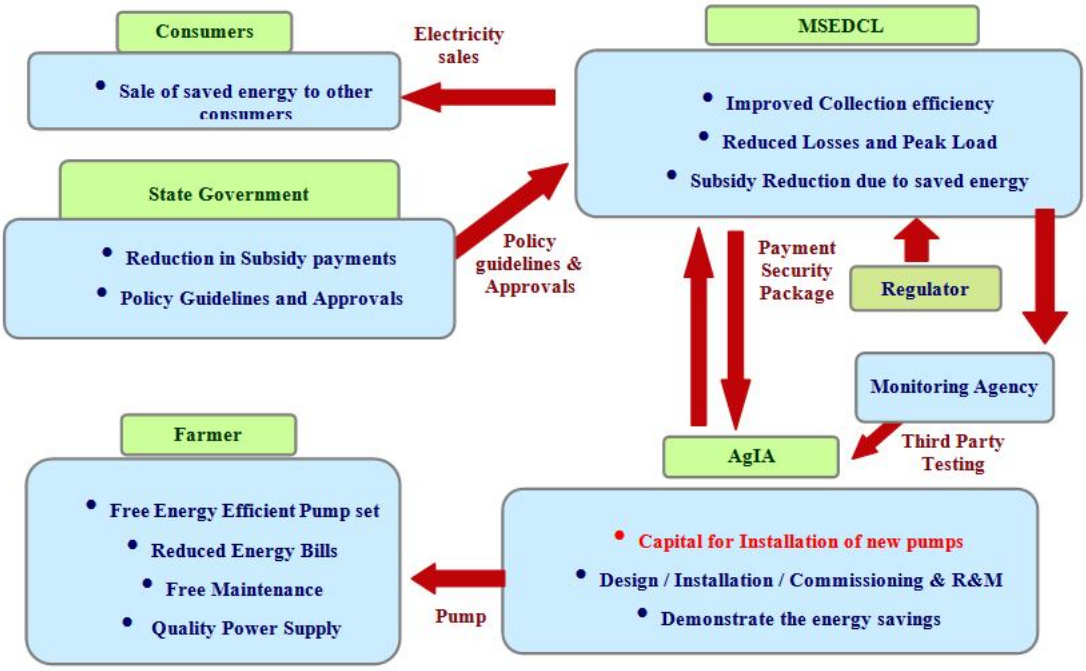

Figure 2: Layout of Pilot Project Implementation Mechanism.

5. Energy Savings

This pilot project reflects savings of 25% over the baseline measured and the overall efficiency has improved from an average of 22.19% to **39.68%** which is more than one and half times the existing efficiency figures. The average energy consumption per pumpset has reduced from 6.63 kW to **4.94 kW** thereby giving an average savings of 1.7 kW. Average reduction in pump installed capacity is in the range of 0.5 HP. It is possible to realize further gain in overall efficiency to around 40% by improving voltage and power supply quality at the pump connections by implementing HVDS at project feeder areas.

Table 1: Comparison of Operating Parameters for Old Pumps Vs New EEPS Installation.

		Old Pumps						New Pumps					
Feeders	Sanctioned	Voltage	Power Usage	Discharge	Total Head	Old Pump	Efficiency	Voltage	Power Usage	Discharge	Total Head	New Pump	Efficiency
units	HP	V	KW	m^3/hr	m	HP	%	V	KW	m^3/hr	m	HP	%
Feeder 1	4.45	388	6.39	19.02	35.0	4.97	22.45	385	4.75	23.50	37.02	4.49	40.67
Feeder 2	4.07	353	5.83	22.35	24.3	4.66	22.89	350	4.37	26.96	26.70	4.23	41.47
Feeder 3	6.24	380	7.29	22.27	25.8	6.43	20.51	376	5.52	25.87	27.35	5.60	33.62
Feeder 4	4.71	365	7.16	17.11	49.3	5.74	21.84	357	5.24	21.21	51.16	5.06	39.96
Feeder 5	4.95	371	7.05	19.89	34.9	5.41	22.30	369	5.25	24.23	36.94	5.06	39.45
Average	4.71	368	6.63	20.16	33.8	5.31	22.19	363	4.94	24.46	35.91	4.78	39.68

6. Challenges/Barriers faced

- Pump ownership with 2 – 3 families is one of the biggest hurdles for entering into pump replacement agreement.
- Farmers fear that metering of the pumps power consumption will be later billed to them.
- Farmer by-passes the energy meter post installation of the new pump and energy meter.
- Farmer’s are reluctant to have their pump HP reduced. The agreements for replacements have been signed only if the new pump HP is nearer to old pumps HP. Presently 56% of the old pumps (1244 out of 2209 pumps) have been replaced with same HP EEPS.
- Low voltage issues, voltage and water level variations at several installations. Due to water level variations, it was felt to provide a higher head operation pump set to farmer for future trouble free operation purpose.
- Farmer’s reluctance to enter into an agreement for pump replacement as this is the first time where a pump replacement scheme involves having an agreement.
- Very old and rusted GI pipes used and lower diameter pipe used in Bore wells.
- At several locations, it is imperative to replace at free of cost all pump set accessories with new ones like panel box, auto starter switch, fuse carrier, wiring/cable, suction pipe, bends, nipples, clips, tin cover, flanges, foundation

board, footing, Nylon rope, NRV, etc. in order to achieve desired results of replacement with efficient pump. Pump starters at several places have been replaced at no cost to convince farmer's regarding the scheme's advantage.

- Few farmer's are reluctant to give back the old pumps as replacement and hence difficulty to enter into the agreement.

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