Report on impact assessment and scoping study of the AgDSM program driven by EESL

January 2021

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Telangana	Mr. Hemanth Kumar (EESL State Head, Telangana), Mr. B Chandrashekhar.
UP EESL Team	Mr. Alok Kumar Mishra (EESL State Head, Uttar Pradesh), Mr. Animesh Agarwal (Assistant Manager – Technical)

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Abbreviations

AP	Andhra Pradesh
APEPDCL	Eastern Power Distribution Company for Andhra Pradesh ltd.
APERC	Andhra Pradesh Electricity Regulatory Commission
APSPDCL	Southern Power Distribution Company for Andhra Pradesh ltd.
BEE	Bureau of Energy Efficiency
DHBVN	Dakshin Haryana Bijli Vitran Nigam
EEPS	Energy Efficient Pump Set
EESL	Energy Efficiency Services Limited
GWL	Ground Water Level
HERC	Haryana Electricity Regulatory Commission
mbgl	meters below ground level
TSERC	Telangana Electricity Regulatory Commission
TSNPDCL	Telangana State Southern Power Distribution Company Limited
TSSPDCL	Telangana State Northern Power Distribution Company Limited
UHBVN	Uttar Haryana Bijli Vitran Nigam
UP	Uttar Pradesh
UPERC	Uttar Pradesh Electricity Regulatory Commission
UPPCL	Uttar Pradesh Power Corporation Limited

Contents

List of Exhibit

Executive Summary

In Andhra Pradesh, 74,000 irrigation pump sets have been replaced with energy efficient pumps, under the AgDSM program. This program was launched to curb the energy consumption of the agricultural category in the state. The replacements have realized energy savings amounting to 133 million kWh.

EESL appointed Deloitte to conduct an impact assessment of this program through surveys of various stakeholders, for e.g.: farmers, state distribution utilities, manufacturers, service technicians and installing agencies. The study captures the survey of 400 farmers spread across three districts of Andhra Pradesh – Vizianagram, Prakasam and Nellore. Apart from assessing the impact of the AgDSM program on the farmers socio-economic conditions, the study also entails the resource efficiency (impact on ground water levels) of the project.

With respect to the select sample population, the survey results in the following inhibiting factors and way forward for the project.

1. Increased affinity towards use of new technology like the smart control panel and the mobile application to operate the pump. Though, 1/3rd of the sample faced operational problems due to connectivity issues. The farmers have requested ample training for smart control panel usage, to make optimal use of the latest technology.
2. Low awareness with respect water use efficiency, as 85 per cent of the farmers are dependent on the water intensive conventional method for irrigation. Farmers have shown keen interest towards learning about drip irrigation methods.
3. The average operating period of the pump set has increased. This is due to increase in free power supply by AP DISCOMs from seven hours to nine hours. Farmers in Prakasam and Nellore have made good use of this provision, as they have lower ground water levels and bigger farmlands.
4. Increase in employment and business amongst the locals of the state. Almost 100 to 150 locals were employed as service engineers, mechanics and service center managers, during the course of this program.
5. High demand for service centers and technicians in all mandals of the state. This would help in reducing complaints of delayed maintenance which is caused due to large distances of the present service center.
6. The provision of free repair and maintenance has led to monetary savings by majority farmers of the state. Up to INR 2000 per month was saved by every farmer in Vizianagram and Nellore. Comparatively, farmers in Prakasam had lower savings, as beneficiaries had additional expenditure towards replacement of motors in the pump.
7. Farmers have highlighted variations in voltage fluctuation as a major reason for interruptions in the pump operations and pump break downs.

Interviews with other stakeholders reflect that:

1. Farmers require proper awareness regarding pump operations with respect to switching of electrical connections of pumps, which has also resulted in motor burnouts.
2. Absence of real time monitoring of the energy consumption of the pump, which leads to estimating of energy savings, on basis of the calculated energy saving potential at the time of installations.
3. The sale of energy efficient pumps at a monetary cost, may lead to farmers taking better ownership of the pump and not exploitation of the free of cost services.

Along with the impact assessment, options for scaling up the program in Andhra Pradesh, Uttar Pradesh, Haryana and Telangana was explored. Each state has their own schemes and initiatives in place to address energy efficiency in the agricultural category.

A thorough desk review and stakeholder consultations with respective DISCOM officials of the state were conducted for the scoping study. The CEA pump energization reports and the state tariff orders are indicative of growth of pump usage in the agricultural sector. The volume of pumps in the agricultural category of these states have an average growth of rate of 10 per cent.

This volume of pumps lies in a range of few lakhs creating a huge potential for replacements with the new 5 star rated energy efficient pump sets. These are also useful for farmers in areas of adequate ground water potential and rainfall. The following table captures the details of the ongoing energy efficient pump set replacement or addition program in the state.

State	Program Type replacement/ addition	Year of project commencement	Target replacement/ addition	No. of pumps replaced or added*	Pump Ratings (hp)	Potential volume for pump replacement
Andhra Pradesh	Replacement	2017	1 lakh	70000	5	15 lakhs
Uttar Pradesh	Replacement	2017	9000	2400	5	10 lakhs
Haryana	Addition	2019	29000	8000	3hp to 30 hp	6.5 lakhs
Telangana	No current EEPS program in place for the LT agricultural category. DISCOMs are exploring options to increase energy efficiency in its HT lift irrigation category under the AgDSM program.					20 lakhs

The ongoing EEPS program in each state is a reflection of their efforts to curb electricity demand on user end. Hence it is safe to say that further scale up of these programs in the state shall be well received. The current pump replacement potential in each state has varied capacities, due to their varied ground water structure. Majority of these pumps are of the capacity ranging from 5hp to 7.5 hp, as they are affordable and of smaller capacity.

The implementation plan of energy efficient pumps for the next 10 years is given below:

Sl.no	State	Volume of pumps to be replaced per year for next 10 years	Potential savings per annum million kWh	Investment in Cr per year
1	Andhra Pradesh	30,000	53	260
2	Uttar Pradesh	100,000	355[1]	890
3	Haryana	50,000	95	450
4	Telangana	100,000	190	890

[1] Reported by UPPCL – 2018-19

1. Introduction

Agriculture is the primary source of livelihood for about 58 per cent of India's population. Gross Value Added (GVA) by agriculture, forestry and fishing was estimated at Rs. 19.48 lakh crore (US$ 276.37 billion) in FY20 (PE). Growth in GVA in agriculture and allied sectors stood at 4 per cent in FY20.

Essential agricultural commodities export for the April-September period of 2020 increased by 43 per cent to Rs. 53,626 crores (US$ 7.3 billion) over Rs. 37,397 crores (US$ 5.1 billion) in the same period last year.

India has two major cropping seasons' namely the Rabi (Winter Crops) and Kharif (Monsoon Crops). Major crops and plantations grown in India are paddy, wheat, millets, pulses, tea, coffee, sugarcane, oil seeds, cotton and jute, etc.

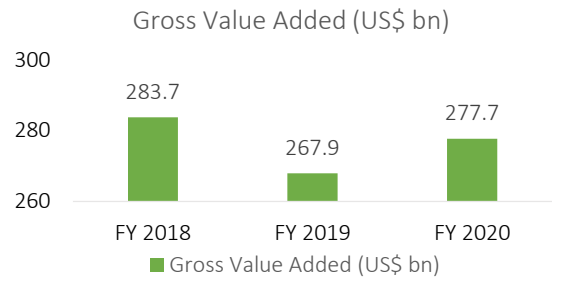


Exhibit 1 Gross Value added (US$ billion)

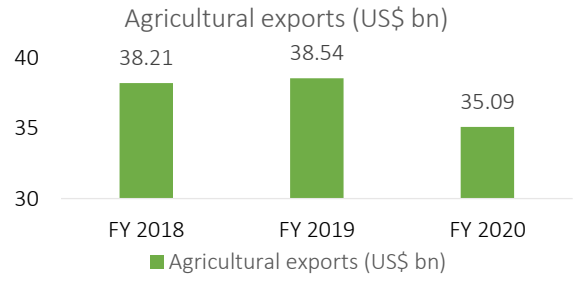


Exhibit 2 Agricultural exports (US$ billion)

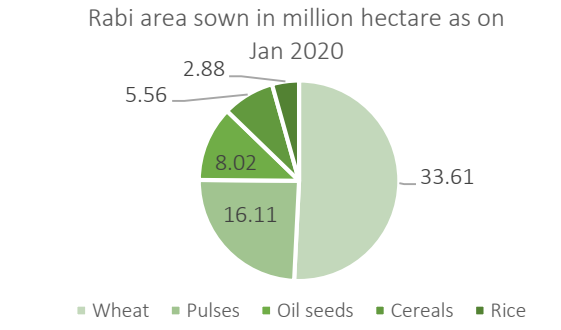


Exhibit 3 Rabi area sown in million hectares

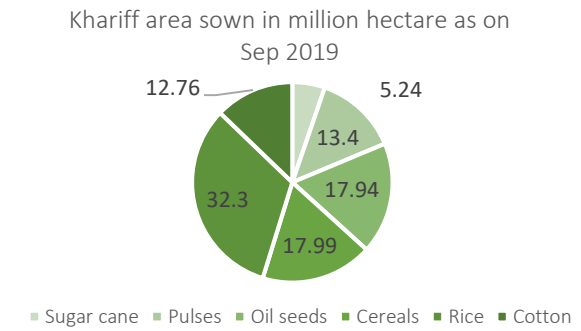


Exhibit 4 Kharif area sown in million hectares

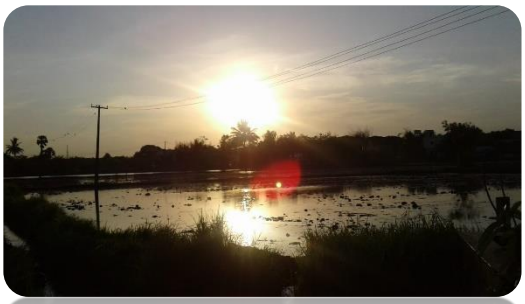
Three major resources[2] – Water[3], Land and Electricity[4] on which the pattern is dependent on are detailed below:

Land

Land – The country has varied soil and agriculture in India consists of various types of farming leading to diverse cropping pattern (IBEF, 2020). Coastal states like Andhra Pradesh, Odisha and other north eastern deltaic regions are major producers of Rice. States like Haryana, Punjab and Uttar Pradesh (The Sutlej Plains) and Rajasthan (black soil regions of the Deccan) are widely known to produce wheat and rice.

Water

The cropping pattern in India is heavily dependent upon the rainfall patterns and the ground water/ water availability in the region. The decrease in ground water level (GWL) is a result of it becoming the mainstay of India's agriculture.



The total annual ground water recharge for the entire country has been assessed at 432 billion cubic meter (bcm) and annual extractable ground water resources for the entire country is 393 bcm.

With an average rainfall of 1215 mm, India experiences a variation in rainfall, ranging from less than 100 mm in the western Rajasthan to more than 2500 mm in North-Eastern areas of the country.

Rivers like Ganga and Brahmaputra in the North, Narmada and Tapi in the West and Krishna-Godavari in the south are few major rivers used as natural resources for irrigation. Pumping of ground water for irrigation accounts for almost 5 to 10 percent of variation in the GWL.

[2] Natural conditions affecting the ground water regime include climatic parameters like rainfall[2] and evapotranspiration, along with anthropogenic influences like pumping of water from the aquifer and recharge due to irrigation systems.

[3] "Ground water extraction for unit power consumption (electric) is determined and multiplied with number of units of power consumed for agricultural pump sets to obtain total ground water extraction for irrigation. "The ground water extraction for irrigation is also assessed through the "Power Consumption Method", This method is an indication towards the indirect correlation between the electricity consumption by the agricultural category and its water use. Along with water use efficiency, India has also been focusing on reduction in ground water extraction through agricultural pump sets.

[4] The Indian agriculture sector is an energy intensive sector and enjoys perpetual low electricity tariffs sold at either at free of cost or at a flat rate to the farmers.

Electricity

The Indian agriculture sectors accounts for almost 18 per cent of the total electricity consumption of the country (MOSPI, 2020). Farmers have used inefficient pump sets and excessively pumped groundwater (CGWB, 2020).

There are about 21 million pump sets across the Indian states responsible for the overuse of power and water (MOSPI, 2020).

Provision of electricity at night has led farmers to use automatic starters, with most pump sets starting automatically at the same time, resulting in a heavy initial load that burdens the overall infrastructure.

These factors have led to frequent motor burnouts and in response, farmers have moved to using less efficient, fluctuation-resistant pump sets. As a result, overall power quality worsens, which in turn leads to increasing pump set and Distribution Transformer damage. (Sagebiel.J, 2016)

1.1 Power subsidy scenario and its impact on the DISCOMs

Subsidies received by state DISCOMs from the state governments are generally provided in lieu of the agricultural sector. The low and flat tariff[5] structure of agricultural electricity supply is a plausible reason for a high financial burden on the state DISCOMs, where in the tariffs are generally lower than the average cost of supply.

Through various data sources, it was inferred that an estimate of the power subsidy was at INR 2339 per ha till the year 2004-05. The total power subsidy since then has accrued to Rs. 81,500 crores by the year 2014-15, across states in India. In concurrence to the abovementioned estimate, reports from the Power Finance Corporation estimates the revenue gap as Rs. 91,000 crores in 2015-16 (ISI, 2019).

The two estimates are of similar order of magnitude and suggests that the power subsidy is comparable to the other `large' subsidies: fertilizer and food. The difference is that the latter two subsidies are borne by the Central government while the power subsidy is a charge on State finances (ISI, 2019).

[5] Under a flat-tariff system, consumers are charged a fixed amount generally linked to horsepower (or kW) rating of the electricity motor used to operate the water pump for irrigation.

Under subsidized power supply scenario, farmers avail the benefit of installing energy efficient pumps, as DISCOMs are investing for replacement of pump sets either by sharing energy savings (in ESCO mode) or through capital investment (PMC mode).

1.2 Demand side management program is an acceptable intervention by all states to conserve energy

Improving end-use energy efficiency to meet the increasing electricity demand and the management of end use demand without having the need to increase the supply are the few of the benefits of the DSM activities.

In 2008, the recommendations from Forum of Regulators suggested that state regulators should constitute DSM cells and pursue the following

1. Submit DSM plans along with Annual Revenue Requirement (ARR)
2. Allow cost of DSM programs as pass-through in the ARR
3. Consider appropriate tariff interventions to support DSM

Despite the existence of DSM regulations in about 17 states and 7 Union Territories, enforcement of these regulations continues to be limited.

However, as a component of the DSM activities, BEE introduced the Agricultural Demand Side Management Program with an objective to reduce the energy intensity of agriculture sector through implementation of energy efficient agricultural pump sets for irrigation.
The intended outcome of AgDSM projects is to:

1. Create awareness regarding energy efficiency amongst the farmers and local utility employees[6].

Under the MoU signed between BEE and the ICAR, around 150 training and awareness programs have been organized in different KVKs covering at least 4000 farmers and stakeholders.

2. Reduction in subsidy load of the central and state governments towards the agricultural category.
3. Stimulation of market in the pumping sector.
4. Robust distribution infrastructure development and technological development to realize energy savings along with reduction in CO2 emissions.

According to BEE's 2018-19 report on Impact of energy efficiency measures, the number of energy efficient pumps getting distributed over the past few years, has realized an energy saving up to around 0.18 billion kWh. The reduction in emission of CO2 realized is 0.148 Million tonne. The

[6] An MoU has been signed between Bureau of Energy Efficiency (BEE) and Indian Council of Agricultural Research (ICAR) to conduct training and awareness programs for farmers to promote the use of Energy Efficient (EE) agricultural pump sets. This would create awareness among the farmers for using Energy Efficient pump sets and its operational practices so as to adopt energy and resource efficient approaches to reduce the cost of cultivation and to increase farmer's income in harmony with strategies of "Per drop more crop" and "Doubling Farmer's income". Till now around 150 training and awareness programs have been organized in different KVKs covering at least 4000 farmers and stakeholders. (BEE, 2019)

calculations were done by considering an overall efficiency factor of 30%. In order to calculate the reduction in total CO2 emission, conversion factor of CO2 for electricity is considered (1 MWh = 0.82 t CO2) (BEE, 2019)

1.3 Energy Efficiency Services Limited (EESL) is pioneering its efforts for AgDSM

EESL has implemented the world's largest Agricultural Demand Side Management (Ag-DSM) program in India, to reduce both peak demand and electricity consumption of the agriculture sector in the state.

The firm started a bulk procurement program in multiple states, where inefficient agricultural pump sets are replaced with BEE 5 star-rated energy efficient pump sets (EEPS). The EEPS is equipped with smart controls enabling farmers to remotely monitor and control options to optimize energy and water use at zero-cost. The replacement also entitles farmers to free repair and maintenance for first five years post installation.

As a part of AGDSM program, EESL implemented a pilot project in collaboration with Government of Andhra Pradesh in Rajanagaram Mandal, Rajahmundry circle in 2016. Under this project, 973 old agricultural pumps were replaced with new energy efficient pumps. Based on the success of pilot project, EESL has installed more than 70,000 EE pumps across the state. Nellore, Krishna and Kurnool districts have seen the maximum installations of the energy efficient pumps.

Considering substantial progress in implementation, EESL has appointed Deloitte to conduct impact assessment of AGDSM program in Andhra Pradesh and explore options for scaling up of this program across in four states in India.

2. Purpose and Methodology

2.1 Purpose of the Study

EESL had planned to install one lakh energy efficient pumps across the state of Andhra Pradesh and is further looking to scale up the program. Hence, the primary aim of this project was to conduct the impact assessment of AgDSM Program and explore options for scaling up in three different states. Exhibit 5 captures the major objectives of the study.

Exhibit 5 Objectives of the AgDSM Program

To fulfill the first objective, the study was conceptualized to understand the impact of various aspects of the AGDSM program on different stakeholders including farmer beneficiaries, utilities and various departments in state and central government. The aspects include environmental and socioeconomic impacts and inhibiting factors followed by recommendations.

1. Impact of AgDSM Program: This assessment was conducted by surveying 400 beneficiaries from the districts – Vizianagaram, Prakasam and Nellore.
    1. Environment: The collected information from the surveys and stakeholder consultation to be utilized to assess the reduction in electricity consumption resulting from implementation of AgDSM program and corresponding GHG reductions. Assessment of

groundwater situation was also considered an imperative parameter, to understand the effect of energy efficient pump set on the ground water table of the state.

2. Socio and Economic impacts: Identification of the socio-economic impacts of Ag DSM program, to perceive the improvements in the beneficiary's lifestyle, development in local employment, awareness of technological development amongst the local youth and monetary benefits realized by the stake holders of the program.
3. Inhibiting Factors and Recommendation: Undertake an assessment of factors that inhibit the implementation and impact of Ag DSM program in rural areas – including awareness, power quality issues, assessment of the power supply side.
    a. The assessment shall than be used to incorporate recommendations from the feedback of the stakeholders and beneficiaries of the program. The feedback and recommendation from them shall be used to put in place, for further planning and execution of the project.

To fulfil the second objective, a detailed secondary and primary research have been conducted to assess the scope of the program in four states in terms of volume of pumps, regulatory obligations, institutional arrangements, willingness of utilities, investments required and tentative action plan for deployment.

2. Upscaling of the program in Andhra Pradesh: Assessing the scope of deployment of Energy Efficient Pumps under Ag DSM program in Andhra Pradesh for the next 3 years and proposing action plans for the potential deployment.
3. Future scoping of the AGDSM program in three states: Apart from Andhra Pradesh, assessing three key states namely Telangana, Uttar Pradesh and Haryana, for deployment of energy efficient pumps with a detailed plan consisting of required investments, key stakeholders and action plan for deployment.

2.2 Research design of the study

The study encompassed primary and secondary research, analysis of research observations, collate the facts and prepare the report. Our detailed methodology is given in the exhibit below:
For impact assessment, massive four hundred field surveys with farmer beneficiaries have been conducted along with stakeholder consultations in select districts. The selected districts were –

1. Vizianagaram district from North Andhra Pradesh
2. Kurnool district from South West Andhra Pradesh, later switched to Nellore in the South East Andhra Pradesh due to pandemic effects.
3. Prakasam district from South East Andhra Pradesh

In order to conduct these surveys in the districts, an initial assessment on the volume of pumps installed and ground water levels of the regions were assessed. The selection of districts was mutually agreed between EESL and Deloitte before commencement of the study.

Even during the pandemic period, resources have spent their time in the field with adequate personal protection to collect the ground level information.

Further, to conduct the scoping study for scaling up the EEPS program, the following states have been selected:

1. Telangana,
2. Uttar Pradesh and
3. Haryana.

The selection of states was mutually agreed between EESL and Deloitte before commencement of the study.

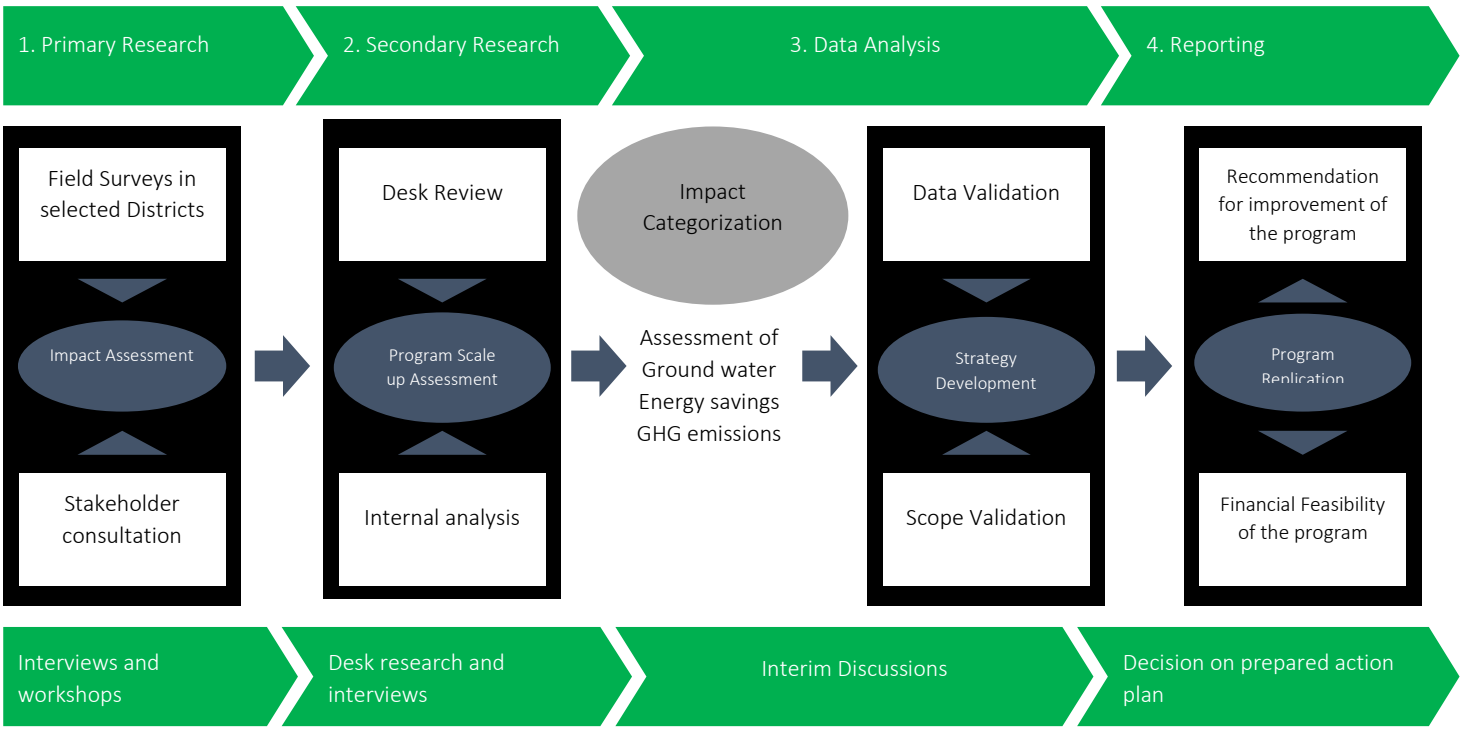


Exhibit 6 Methodology

As a secondary research, a comprehensive review of documents available in public domain and the reports provided by EESL was carried out.

As a primary research, four hundred farmer beneficiary surveys were conducted based on the structured questionnaire as mentioned in the **Annexure -1.** Stakeholder consultation with manufacturers, implementing agencies, distribution companies and installing agencies were conducted through web conferences and telephonic interviews. The key parameters reviewed through surveys, stakeholder consultation and desk research, to determine the expected output is listed in the Exhibit 7.

Sl.no	*Impact*	*Expected output*	Source reference
1.	Environment	1. Electricity savings 2. Emission reductions 3. Water Management - Impact on Ground Water 4. Waste Management - The disposal strategy of the old replaced pumps	**Desk review:** APERC Tariff orders, filed petitions, suggestions and recommendations to regulatory commission, Multi Year Tariff business plans submitted to regulatory commission, detailed project reports, socio – economic surveys and published ground water reports. **Primary research:** On field surveys conducted with farmers
2.	Economic	1. Investment Capability 2. Impact on Subsidy 3. Infrastructure development 4. Cost savings through free repair and maintenance	**Desk review:** APERC Tariff orders and MYT reports. Reports available on public domain on analysis of HVDS implementation in Andhra Pradesh **Primary Research:** On field surveys conducted with farmers and stakeholder consultation with empaneled manufacturers (CRI, Duke and Varuna Pumps)
3.	Social	1. Improved Livelihood 2. Employment generation for locals	**Primary Research:** On field surveys conducted with farmers and stakeholder consultation with empaneled manufacturers (CRI, Duke and Varuna Pumps) and installation agency (Teck Tech services)

Exhibit 7 Key parameters to assess high level impact of the AgDSM program in Andhra Pradesh

Through a combination of desk reviews and the survey, status of the AGDSM program and its effect on stakeholders were assessed. This is an outlook on EEPS as a social, economic and environmental action for the agricultural sector. Based on our assessment, impact assessment findings and recommendations for scaling up the program were given in the subsequent sections of the report.

3. Impact assessment of AGDSM program in Andhra Pradesh

3.1 Introduction

EESL's involvement in the project has help keep a track record of the ongoing EEPS installation in Andhra Pradesh. Survey distribution of districts, Mandals and Talukas visited by the team is mapped below:

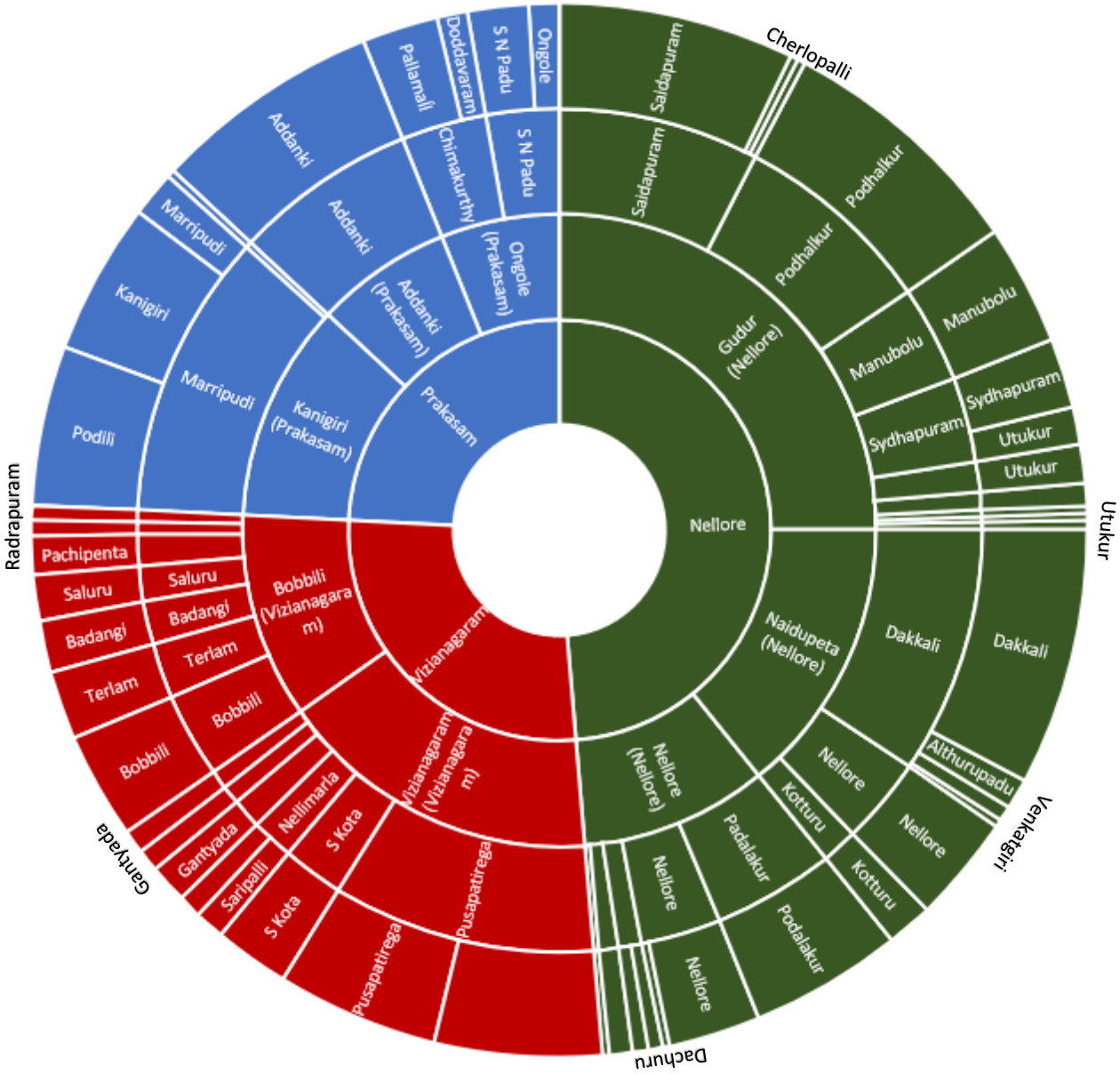


Exhibit 8 Survey Distribution of selected districts

For the impact assessment survey, the list of beneficiaries, enrolled as a part of the program was shared by EESL. The assessment for the AgDSM program in Andhra Pradesh, spread out to the following districts - Vizianagaram, Prakasam and Nellore. A total of 400 survey responses were collected for the assessment. The responses from the beneficiaries were collected from various the mandals and almost 95 villages located in the selected districts.

The mandals and the villages selected for the survey was based upon their:

1. Volume of installation of the new energy efficient pump sets in the village
2. Telephonic confirmation of the farmers availability in the area

The surveys were initiated in the village of Karada located in Vizianagaram. Almost 25 per cent of the survey responses were gathered from 35 villages located in Vizianagaram. The second set of surveys were intended to be conducted in Kurnool. It was later replaced with Nellore, as Kurnool had a rise in the number COVID-19 cases.

Post hitting a similar roadblock in Nellore, the surveys were shifted to villages in the Prakasam district. Like Vizianagaram, 25 per cent of the responses were gathered from 17 villages in Prakasam.

Surveys in Nellore were resumed after the extreme climatic and health conditions of the area had subsided. The remaining 50 per cent of the responses were gathered from Nellore.

Throughout the field surveys, it was realized that the responses from the beneficiaries across the three districts, were varied in nature. Beneficiaries in Nellore seemed more confident with the use of the energy efficient pump sets than in Prakasam.

The findings of the impact assessment survey have been detailed further in the section.

3.2 Impact assessment results

The impact assessment has been divided into economic impacts, environmental impacts and social impacts. This report highlights the experience of various stakeholders including farmers, vendors and government stakeholders have on AgDSM Program implemented in Andhra Pradesh. It assesses the level and nature of the broader socio-economic impact of the energy efficient pump initiatives on farmer (beneficiaries).

3.2.1 Farmer assessment profile

As mentioned above, we have met 400 beneficiaries across three districts in Andhra Pradesh. Amongst 400 beneficiaries, 340 of them are male and 60 females with the age profile ranging from 30 to 70.

Volume of beneficiaries, age profile, education qualification and land owned by them have been presented below:

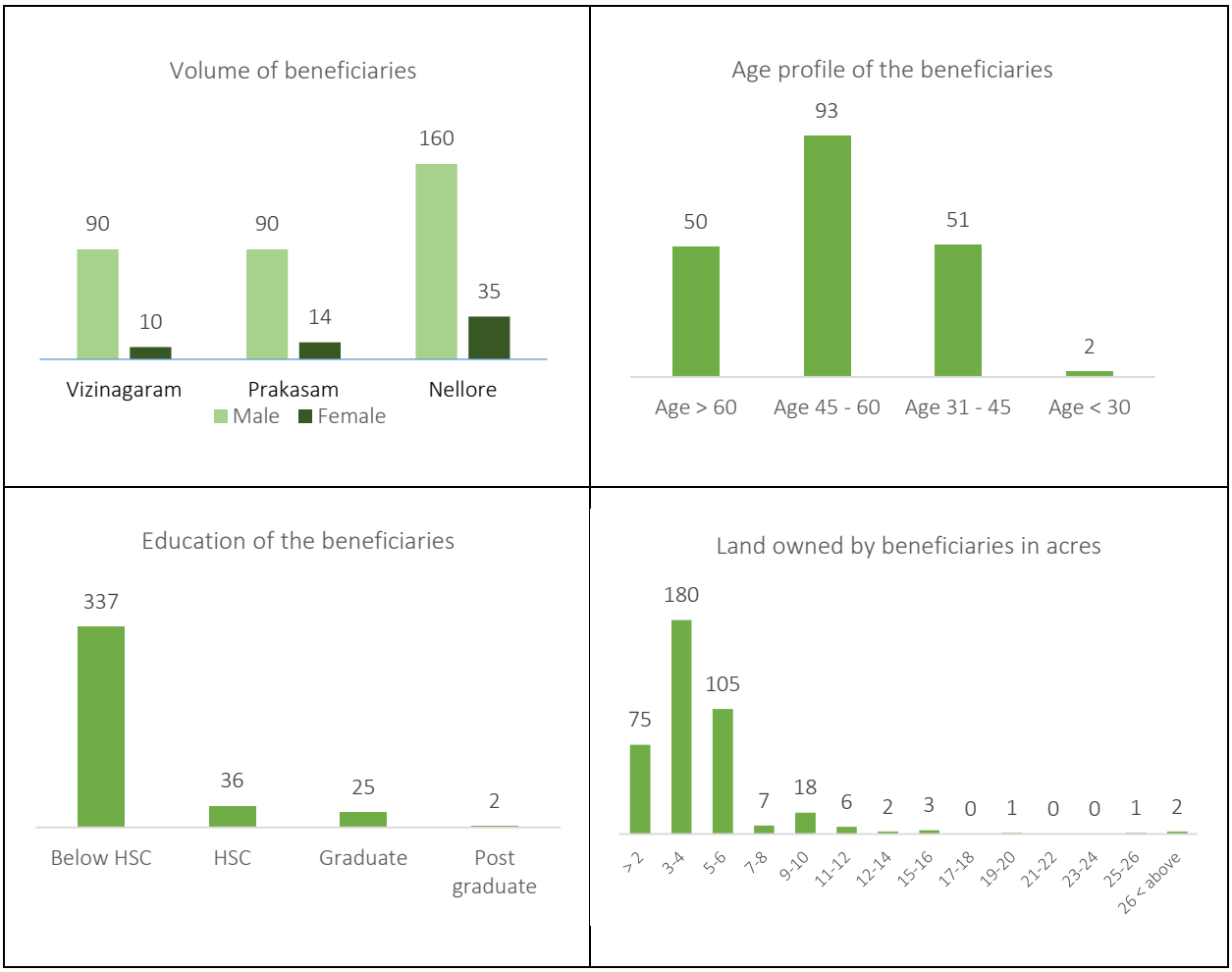


Exhibit 9 Beneficiary Profile

The survey was planned to meet 150 beneficiaries in Prakasam, 100 beneficiaries in Vizianagaram and 150 beneficiaries in Kurnool. While we had conducted interviews for the targeted numbers, we were not able to meet enough numbers in Prakasam due to the increased pandemic in the district.

Age of the beneficiaries ranging from 30 (very few) to 70 and most of the beneficiaries whom we have met were aged between 45-60. On the education qualification, majority of the beneficiaries have qualification below HSC and around 25 of them are graduate and 2 of them are post graduate who were into farming.

Most of the farmers were holding land area between 3-6 acres. On an average, land area owned by each farmer in Vizianagaram was around 4.4 acres, Prakasam around 5.3 acres and Nellore around 8.9 acres. During our discussion, it was understood that most of the farmers have moved from traditional bullock cart to tractor and advanced machinery for farming purposes. Out of 400 farmers, only 3-4 of them have been using bullock cart and rest of them moved to tractors. Around

32 of them own tractors for their farming purposes. Around 129 of them have informed that they don't have tractors however they rent tractors locally for farming.

3.2.2 Farming and cropping

Farmers have informed that they adopt three types of farming.

1. Conventional method – or Flood irrigation is a simple and inexpensive process of directing water down furrows located next to plantings. The water floods the area around the plant and soaks into the soil. This method is the most popular irrigation methods used today, however it leads to water loss due to poor irrigation practices and evaporation.
2. Drip irrigation - is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation.

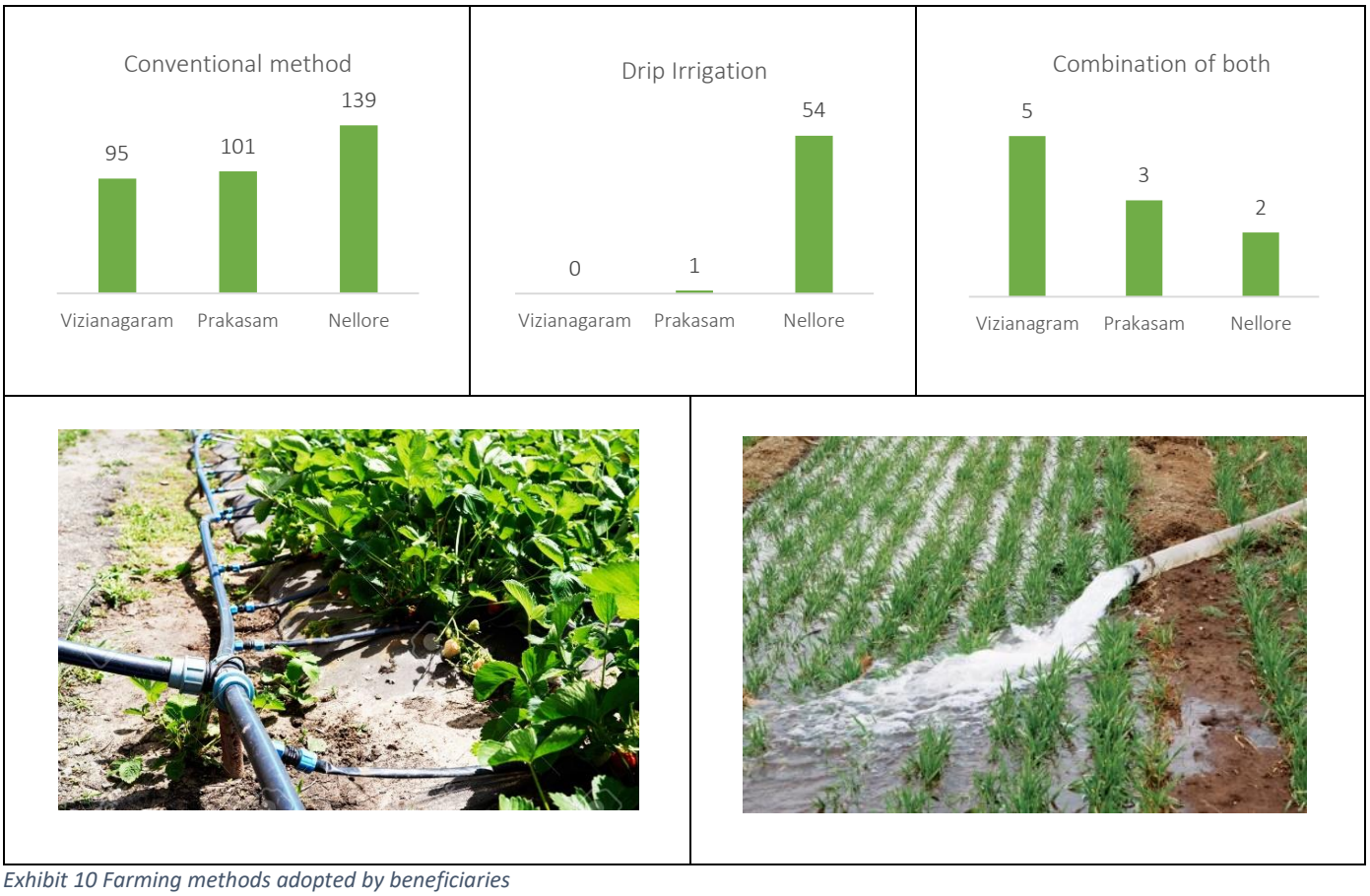


Exhibit 10 Farming methods adopted by beneficiaries

Conventional method of irrigation is primarily adopted by most of the farmers across all three districts for major water intensive crops like Rice, Sugarcane, Plantation, Lentils, Maize, Groundnut, Tobacco, Coconut, etc. In our sample population, around 85 per cent of the farmers adopted water intensive conventional method for irrigation. 15 per cent of farmers have adopted

drip irrigation for harvesting lemon and chilies. **Water conserving drip irrigation is yet to gain popularity among farmers in three districts in Andhra Pradesh as per our sample assessment.**

3.2.3 Energy efficient water pumps

EESL has implemented a 5 hp (3.75 kW) energy efficiency pump sets across all three districts in Andhra Pradesh. During our interview, farmers have highlighted that they came to know about these programs from various channels including local newspapers, government channels, friends and neighbors, local panchayat etc.,

Most of the pump sets were installed between FY 2017 to FY 2019. Two major service providers CRI pumps and Duke pumps have supplied pumps across these three districts. In our sample, around 74 per cent of the pumps were supplied by CRI pumps and rest 24 per cent were supplied Duke pumps. Post installation of new pumps, old pumps were recovered from farmers for disposal.

New pumps have been installed at the same depth as of the old pumps in all districts.

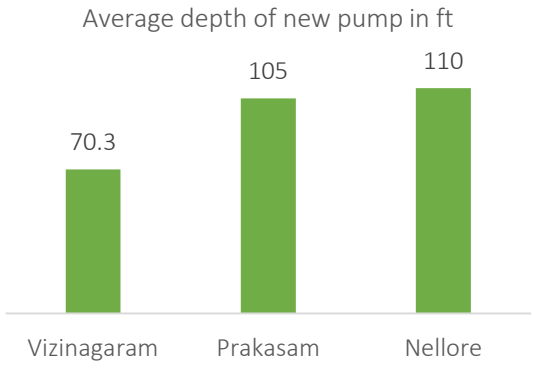


Exhibit 11 Average depth of new pump

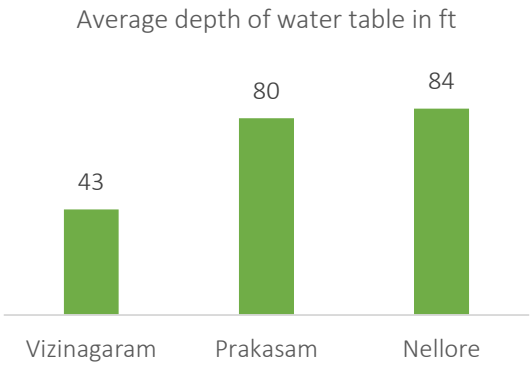


Exhibit 12 Average depth of water table

The above chart explains the depth at which the new pumps were placed in each district. Since Vizianagaram possess better water table compared to other two districts, the installation depth was significantly lower than other districts. **It is pertinent to note that the power capacity of the pumps is uniform across the districts irrespective of the depth of installation of the pumps**. In order to understand better, the pump operating period was analyzed before and after installation of pump.

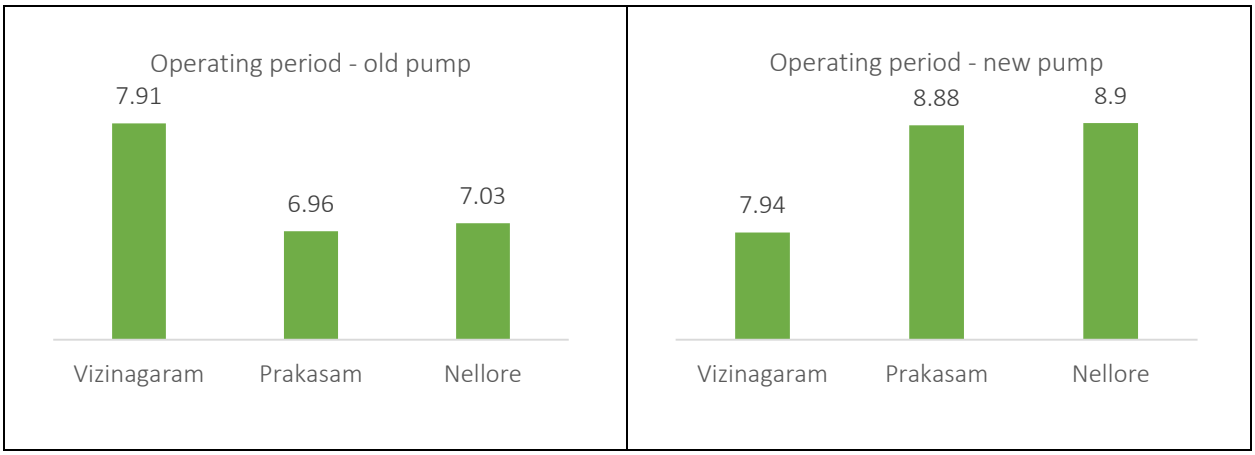


Exhibit 13 Operating period of pump sets

It was observed that the operating period of the new pump was higher in both Prakasam and Nellore districts compared to old pumps. The operating period was unchanged in Vizianagaram. While there could be many reasons for increment in operating period, one of the key reasons could be the power capacity of the pump concomitant to the depth of pump installation and water table.

In addition, AP DISCOM have also allowed farmers to increase the operating period from 7 hours to 9 hours per day. Due to higher depth for same pump size, Nellore and Prakasam district farmers have increased their operating period.

Out of 400 farmers, only two farmers in Nellore reported that they have lowered their new pump due to decrease in water table in the nearby region.

Our discussions across districts led us to understand that around 50 farmers have mentioned that they have supplied excess water if any to their neighboring farm fields, post installation of new pumps.

No significant change in cropping patterns or crop yield before and after implementation of energy efficient pump sets has been observed by the farmers.

3.2.4 User experience - pump operation

Since the energy efficient pump sets were equipped with smart control panels and remote operation of pumps through mobile, we have interviewed the farmers to understand their experience on the usage of it.

Amongst 400 samples, only 49 of them have mentioned that they know how to operate the pumps through mobile and operate it on regular basis and rest of them had informed either they how to know operate but they operate the pumps manually.

Our assessment for the user experience is as follows:

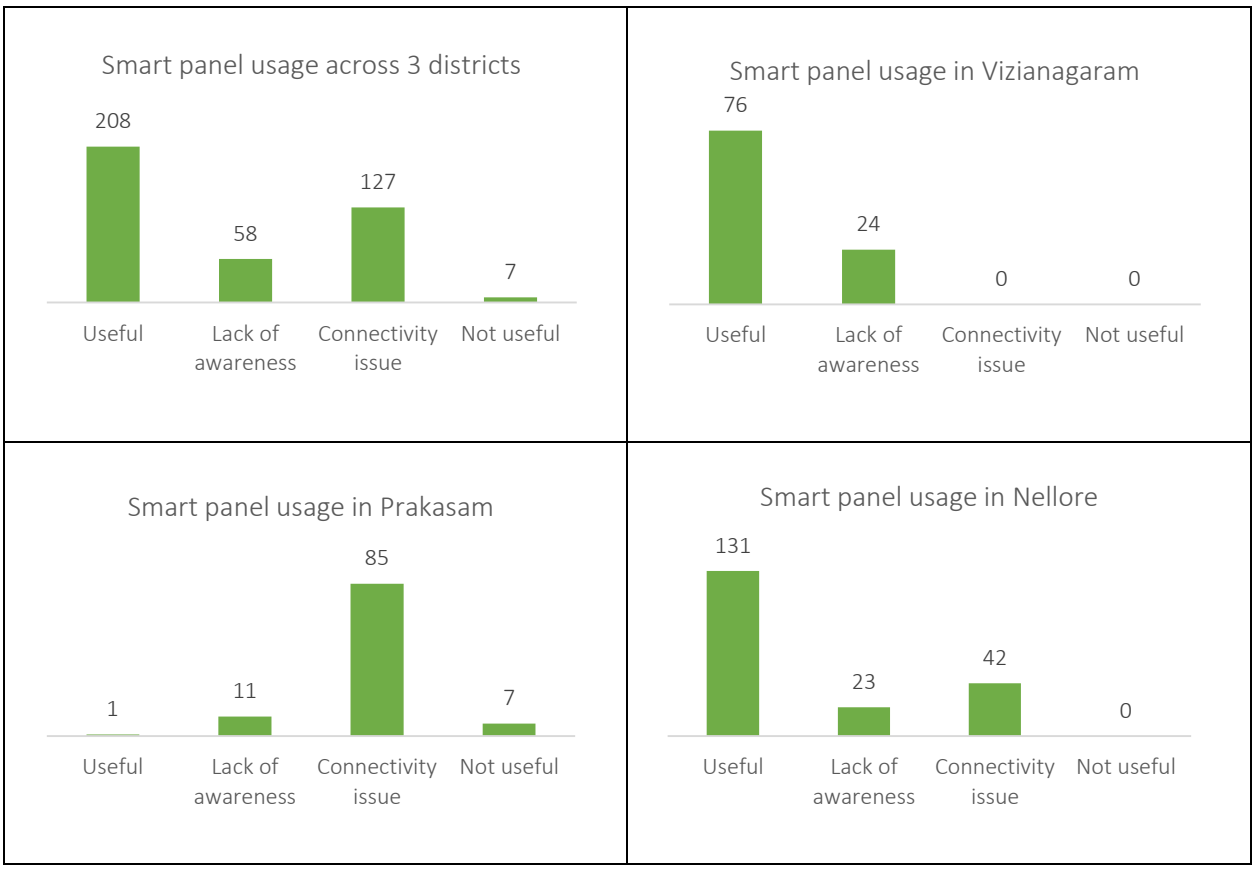


Exhibit 14 Use of smart panels

From our sample assessment, it is very evident that around 50 per cent of the farmers have found the energy efficiency pumps with smart control panel useful. But, nearly 1/3rd of them, faced connectivity issues to switch on and off the pumps. The smart control panel is operated through a mobile network and a sim card. Since the sim card was not recharged, farmers were unable to use smart control panel. In Prakasam district, since most of the farmers faced issues with connectivity, they were not very supportive of smart control.

Voltage fluctuations in agricultural feeders and distribution transformers, were identified as another major road - blocks to the agricultural consumers. Across all three districts, farmers have been facing pump stoppages due to voltage fluctuations. Pumps were stopped as low as 5 times a month to as high as 2 times a day due to voltage fluctuations. One of the key reasons found to be the voltage surge from the nearby distribution transformers.

As the farmers faced issues related to connectivity, most of the farmers stopped using smart control and moved to manual mode. The manual mode operation did not help the farmers as they had breakdowns of the pump at frequent intervals.

2.2.5 User experience – complaints redressal

Since few of the farmers faced issues connected with pump operations, we have reviewed the user expereince of the complaint redressal mechanism established in three districts.

As a first step, it was assessed in each district that who would be the first point of contact upon breakdown of the pump. District wise assessment is given below:

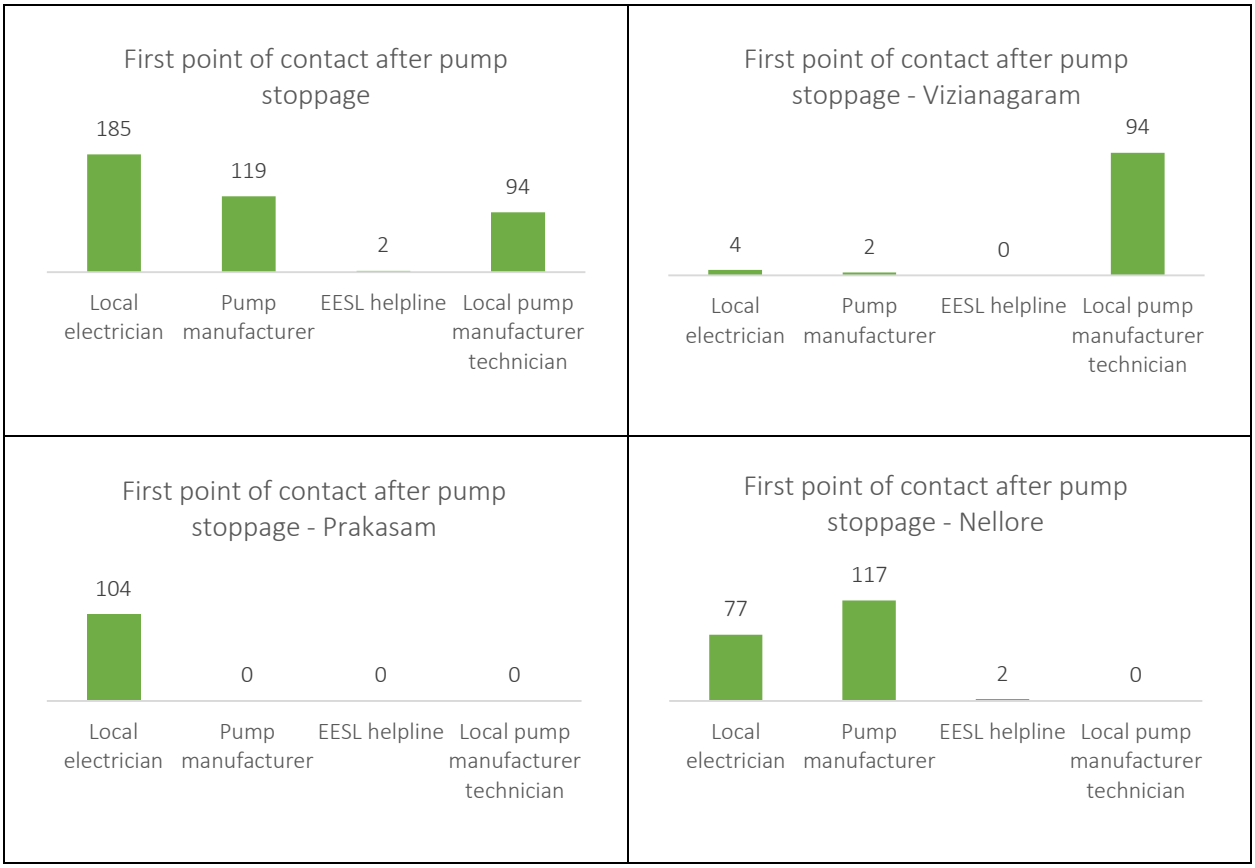


Exhibit 15 First point of contact for repair and maintenance

While mixed opinion was observed, majority of the farmers have preferred contacting local electricians over other options. However, the overall opinion is widely skewed across districts. In Vizianagaram most of the farmers preferred to contact the local pump manufacturers technician over pump suppliers like CRI or Duke as their response time is quick.

Prakasam preferred only local technician and Nellore we received mixed feedback. They call either local electrician and pump supplier (pump manufacturer) over other options.

Distance of nearest service centers from the districts surveyed:

1. Vizianagram – 25 to 30 kms
2. Prakasam – More than 80 kms
3. Nellore – 20 to 30 kms

Average per day complaint visit by manufacturer's service engineer in each district - 5

EESL helpline was least used as farmers found it difficult to lodge a complaint. Hence most of the farmers prefer other options over EESL helpline.

Secondly, farmers prefer local technician or local pump manufacturer because most of the pump supplier service center is far off from the pump location and they take more than 10 -15 days to respond to the service complaint. Many of the beneficiaries also discussed the delayed time duration of response in provision of services which leads to incurring cost of repair and maintenance to the farmers.

About 25 per cent of the beneficiaries in Vizianagaram have conferred that due to the distant location of service centers from their division, the pump repair and maintenance issues take more than 3 days to be resolved. In case of Prakasam district, the beneficiaries have shown lower levels of confidence as the nearest service center for the energy efficient pump set is at approximately 80 kms from the surveyed divisions.

More than 90 percent of beneficiaries in Nellore mentioned that the complaints get resolved in less than 3 days as their preferred method of resolving complaints is contacting the local electrician.

3.2.6 User experience – awareness and training

Beneficiaries limited knowledge on the workings of mobile app and smart control panel inhibits them to do fully exploit the new technology. This was conferred from the feedback given by 75 per cent[7] of beneficiaries, regarding the training on energy efficient pump set. Training and awareness related responses from farmers is given below:

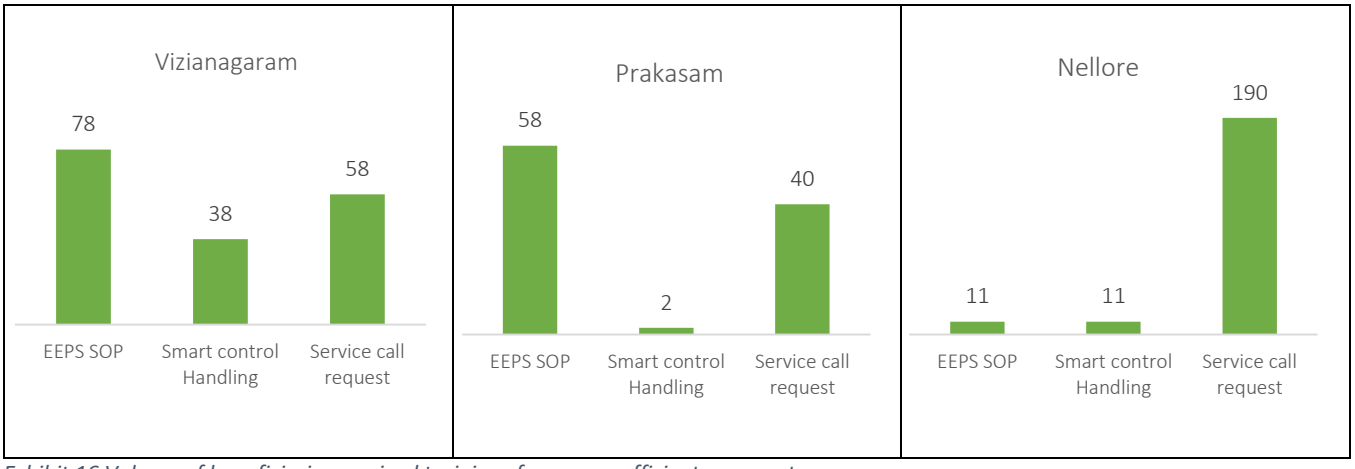


Exhibit 16 Volume of beneficiaries received trainings for energy efficient pump set

They have requested for specialized trainings for mobile app handling and use of smart control panel, as most of them were trained only on the basic aspects of pump operations.

[7] Detailed survey regarding training specific to Smart Control Panel and mobile application use, was elaborated post surveys in Vizianagram. All beneficiaries in Prakasam and Nellore have confirmed that trainings were given in groups, only with respect to basic operations of the pump.

3.2.7 Over user experience

In total, around 325 farmers were satisified with the program and remaining 75 farmers have either one or more issues which made them slightly unsatisifed.

3.2.8 Expectations from the farmers – way forward

1. Farmers in Nellore expect that every mandal in Nellore should have a service center for swift customer support. While it is an expectation from Nellore, it was also being expected by farmers in other districts.
2. Farmers have highlighted that the DISCOM can maintain limited variations in the voltage levels so that their pump sets would not get tripped.
3. Farmers have requested to rectify the issues concomitant to panel complaints on time as it will be useful for all farmers.
4. Farmers in Vizianagaram requested to resolve the connectivity issue faced while operating pumps through cell phones and provide training connected to smart control.
5. Farmers in Prakasam district requests to improve the quality of services offered through nearby service center and also increase the number of service centers for quick services.
6. Farmers have solicited to provide more awareness and training programs to introduce EE pumps and for efficient operation.
7. Farmers are interested to learn more about drip irrigation techniques (although this is outside the boundary of EESL)

3.3 Environmental Impacts

The environmental impact category captures the following elements of the program:

1. Electricity savings and CO_2 emission reductions
2. Water management - Impact on the ground water levels
3. Waste management – The disposal strategy of the old replaced pumps

3.3.1 Electricity savings and CO_2 emission reductions

The Andhra Pradesh distribution companies have replaced 74,000 agricultural pumps with the energy efficient pump sets, since the inception of the project in 2017. An estimated energy savings of 133 million kWh and 109133 tonnes CO_2eq of estimated CO_2 emission savings has been realized, due to the implementation of the project.[8] Since these figures were publicly reported by AP DISCOM the same have been reported.

[8] These savings were theoretically calculated as per the savings reported in the MYT business plans submitted by the Andhra Pradesh state distribution company to APERC. (APEPDCL, 2018) Monthly energy savings values are requested from the distribution companies from APERC at the inception stage of the project.

3.3.2 Water management - Impact on the ground water levels

As published in the National Compilation on Dynamic Ground Water Resources of India, 2017 by the Central Ground Water Department, the total annual ground water recharge of Andhra Pradesh in 2017 was estimated as 21.22 billion cubic meter (bcm) and annual extractable resource was 20.15 bcm.

When compared to the assessment in 2013 the total annual groundwater recharge for the State had increased from 20.39 bcm to 21.22 bcm, which would be attributed to government interventions like the Neeru-Chettu water conservation activities and emphasis on Micro Irrigation (CGWB, 2020).

The total ground water extraction by the state's irrigation category in 2017 was around 7.35 bcm, becoming the topmost consumer of ground water resource in the state. Through review of the socio-economic surveys published by the government, it was observed that the average ground water level in the state has risen by 3.60 m since 2019. (AP, 2020) Though ground water extraction in Andhra Pradesh is maximum through agricultural pump sets, heavy rainfalls during the years 2018 and 2019 has replenished the ground water aquifers in the state.

The following exhibit is an indication of the surveyed beneficiary's awarenes towards the ground water levels of the area and their awareness on water use.

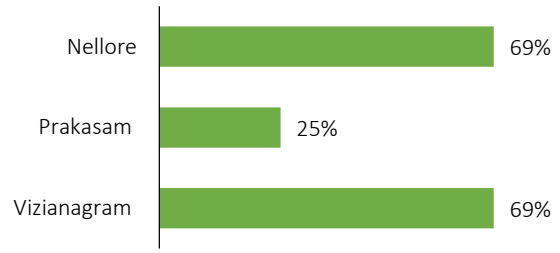


Exhibit 17 Beneficiaries Awareness on the ground water scenario of the district

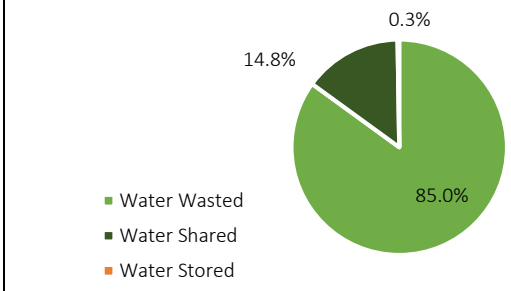


Exhibit 18 Share of beneficiaries aware on saving the surplus pumped water

More than 65 per cent of the beneficiaries surveyed in the Vizianagram area have conferred that the ground water levels are in between 6 to 7.6 mbgl. Also 100 per cent of the beneficiaries surveyed in the Vizinagram area have stated that no extra measures were taken to enhance the extraction of ground water.

Hence it is inferred that there was minimal effect on ground water levels post the implementation of the EEPS program.

More than 25 per cent of the beneficiaries surveyed in the Praksam area have conferred that the ground water levels are in between 17 to 19 mbgl, which subsequently concurs with its reported ground water level.

In Nellore, the 70 per cent of the surveyed benficiaries are fairly aware of the ground water levels as they concur to the reported values of 10 to 12 mbgl.
Initiatives like "Pradhan Mantri Krishi Sinchai Yojana (PMKSY)"[9] with slogans "Per Drop, More Crop" are being implemented in the state to create awareness regarding the water use efficiency. In contrary to the state's effort to create awareness on water use efficiency, the survey indicates that farmer's choice of farming and awareness on water conservation is relatively poor. *85 per cent of farmers use conventional method as their choice of farming as explained above.* However, farmers have also expressed their interest in awareness regarding drip irrigation.

3.3.2 Waste management – The disposal strategy of the old replaced pumps

Waste management of the old replaced pumps was completed, following the below given steps:

Step 1: At first the replaced old pumps were collected on site, by the installing agencies
Step 2: They were then delivered to the district stores of the respective distribution company of the area
Step 3: The respective DISCOM's had then taken different approaches for the end of the process.

District store officials from APEPDCL during the consultation mentioned, that the pumps were sold to the highest paying scrap dealer in an e-auction organized by their corporate office. APSPDCL on the other hand confirmed that the old pumps were scrapped (dismantling pump parts) in their district stores. The scraps were then sold at a minimal price to the scrap dealer in their area.

3.4 Economic Impacts

The following parameters have been assessed to arrive at economic Impact due to the program:

1. Investment capability
2. Investments in the distribution infrastructure for the agricultural category
3. Savings incurred due to free repair and maintenance of the new EEPS.
4. Subsidy load on the State Government

During the initiation of the AgDSM program, the total project cost estimated for APSPDCL was at Cr INR 292.54 and for APEPDCL was estimated at Cr INR 157.02.[10] (APSPDCL, 2017)

[9] Schemes like Pradhan Mantri Krishi Sinchai Yojana (PMKSY) Har Khet Ko Pani (HKKP) have been implemented in several states - Ground Water Irrigation, for creation of irrigation potential through ground water in assessment units where there is scope for further future groundwater development. Water conservation measures are also taken up as a part of the Mahatma Gandhi Employment Guarantee Act 2005 (MGNREGA).

[10] The orders passed by the Andhra Pradesh Electricity Regulatory Commission in 2017, stated that the implementation of the AgDSM project would be completed with the capital investments done by the state distribution companies.

The distribution companies were suggested to invest on the replacements of distribution transformers with the High Voltage Distribution Systems (HVDS) by EESL and APERC.

As provided in the tariff orders by the APERC, APSPDCL has initiated the replacements with the HVDS system which has resulted in decrease of at least 10 per cent of T&D losses in the category (AP S. , 2020).

Meanwhile the APERC had requested to design and supply the EEPS at wider voltage range to withstand the fluctuations. To satisfy these conditions, the empaneled manufacturers were provided with the following design specification while presented with the letter of award –

1. Pump Sets shall operate at wide voltage.
2. Power Factor shall be greater than or equal to 0.75 at rated conditions without the use of capacitor. Further, the power factor should be greater than 0.93 with suitable rating of capacitor.
3. The starter should be fitted with a Contactor and Thermal Overload Relay for 5 hp ratings.
4. The Contactor AC 3 phase (for highly inductive load) current rating (at 415 V_{ac}) should be as per applicable calculations with respect to 5 hp rating of the pump set. The voltage range of Contactors should be between 250 V to 455 V.

Though the supply of pumps were done at the given design specifications, farmers in the surveyed districts discussed the effects of continuous voltage fluctuations on their pump operations as explained above.

Due to lesser maintenance related issues compared to their older pumps, the farmers have gained minimal monetary savings post implementation of energy efficient pump sets.

Some beneficiaries in Vizianagaram and Nellore have confirmed savings of up to INR 2000 per annum per farmer due to free repair and maintenance, the others in Prakasam experienced an increase in the average cost of maintenance by INR 500 to 1000 as they preferred rectifying the technical issues with help of a local electrician.

3.5 Social Impacts

The social impact category is reflection of the development in wellbeing of the stakeholders through

1. Improved Livelihood - Changes in livelihood of the beneficiary post implementation of the program.
2. Direct and Indirect employment - Effect on the direct and indirect employment for the locals in the state.

Through multiple request raised by the farmers to the distribution companies, the free power supply to the agricultural consumers were increased for electricity supply from seven hours to nine hours per day. This was a relief to the farmers as mentioned in their feedback, as they now have more flexibility towards their pump operations. The major reasons for flexibility in continuous operations of pumps on field occurs while irrigating the paddy fields which are classified as water intensive crops.

90 per cent of the farmers utilize the new installed pump sets for a continuous period of 9 hours.

Equipped with the smart control panel and operation of the EEPS with mobile applications, the new technology has urged the farmers to opt for monitoring pump operation from remote locations. Farmers have shown immense enthusiasm towards the technology requesting detailed trainings for the operation of smart panels and rectification in sim card recharge issues.

More than 70 per cent of the beneficiaries in Vizianagaram have conferred that they would like to adopt the new technology, as it helps in the ease of pump operations.

The pump manufacturers and installing agency conferred that during the inception of the program, steps like group trainings were provided, where farmers in a group of 30 to 35 were explained the operability of the smart control panels on the energy efficient pump sets. Along with group trainings the manufacturers have also provided the farmers with an instruction manual in their local language.

The installing agency utilized their skills on field to encourage farmers, who had not opted for the program, to witness the installation process and learn about the functions of the energy efficient pump sets. In contrary to the efforts taken by the stakeholders to educate the farmers.

Apart from the beneficiaries, the state's local population has been benefited by the program. The manufacturers and installing agency helped in local employment thereby the local economy, by establishing new service centers and authorized service centers at multiple location of the district. The AgDSM program has given rise to employment generation of about 100 - 150 locals as service engineers, technicians and project managers. Not only through employment generation, but also capability development to the youth has led to an awareness regarding energy efficiency in the agricultural field and its benefits.

Having analyzed various impacts, the summary of them along with their validated outputs are tabulated below:

Sl.no	Impact Domain	Expected Output	Output Validated through desk review and field surveys
1.	Environmental Impact	1. Electricity savings 2. Emission reductions 3. Water Management - Impact on Ground Water 4. Waste Management - The disposal strategy of the old replaced pumps	1. Electricity savings – Load reduction and energy savings of 133 million kWh 2. Emission reductions – CO_2 emissions reduced by 0.11 million tCO_2eq 3. State's Ground water potential increased as the levels have risen by 3.6 m in the year 2020.
2.	Economic Impact	1. Investment Capability 2. Impact on Subsidy load 3. Infrastructural Development 4. Savings through free repair and maintenance	1. Investment Capability – More than Cr INR 450 capital investment is being met by APSPDCL and APEPDCL for the project. 2. Infrastructural Development – Installation of HVDS systems for 2,96,374 agricultural services, with an investment of Cr INR 744.50 (AP S. , 2020, p. 124) 3. Savings through free repair and maintenance
3.	Social Impact	1. Improved Livelihood 2. Employment generation for locals	1. Improved Livelihood with respect to peace of mind due to ease of pump operations from remote locations. 2. Employment generation for locals in the state – 100 to 150 locals hired for the AGDSM project

Exhibit 19 Summary of impact assessment output for Andhra Pradesh

4. Future scaling up of AGDSM program in Andhra Pradesh

The scoping study aims to assess the upscale potential of AGDSM program in Andhra Pradesh and three key states which will be explained in subsequent sections. Exhibit 20 captures the major categories focused upon to determine scale up potential in each state.

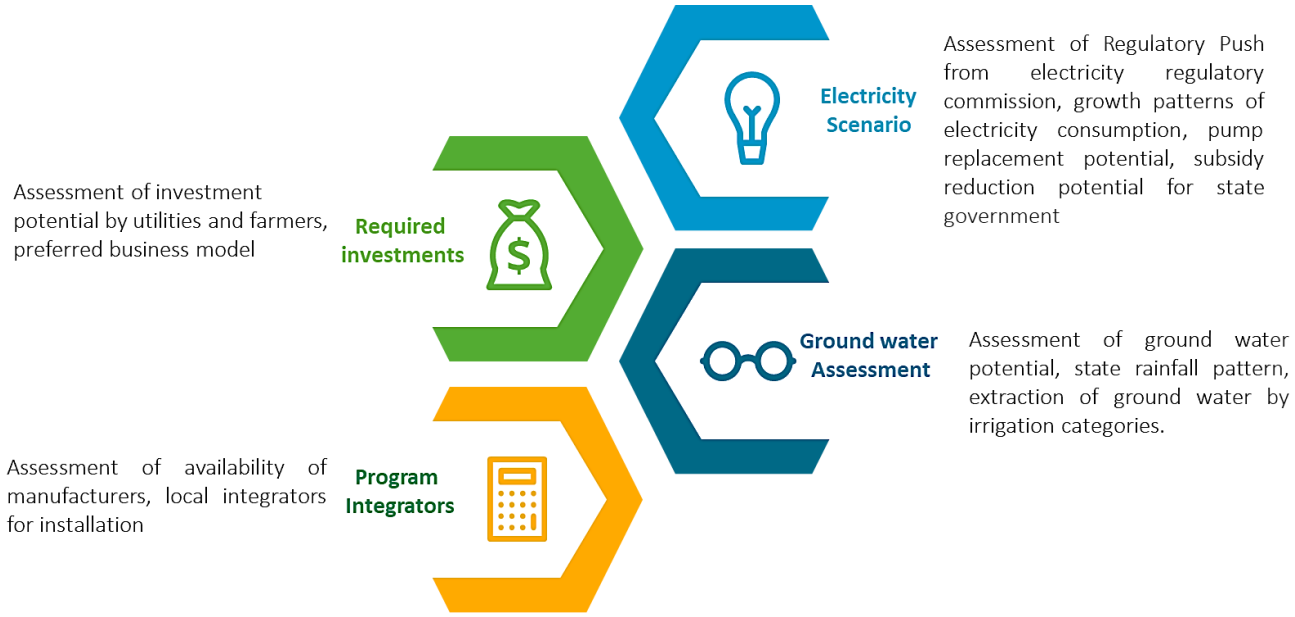


Exhibit 20 Methodology of the Study

4.1 About Andhra Pradesh

With 13 districts in the state and area of about 1.6 lakh sq. m, Andhra Pradesh is the 8th largest state in India. It is predominantly an agrarian state. The overall economic growth of the state is essentially driven by the services sector which has contributed the highest GVA growth of 9.11 per cent in 2019-20 followed by the Agriculture and Allied sector with 8.60 per cent growth (AP S. , 2020). Andhra Pradesh aspires to provide services and technological transfer to the farming community under the Agriculture Sector. The state government is determined to focus on the sector's:

1. Productivity enhancement
2. Mitigating the impact of droughts
3. Implementation of waste management post-harvest season
4. Strengthening the agricultural value chain

4.2 Cropping and Irrigation Pattern

The state is known for its production of paddy, maize, pulses, millets, sugar cane, poultry and aquaculture. The crop production of the state follows the Kharif and Rabi seasons. Apart from the seasons, the cropping pattern also depends on the irrigation area. The state observed a fall in the gross irrigated area by 0.15 lakh hectares during 2015-16, which led to reduction in crop production. The net area irrigated of the state in 2018-19 is 27.96 lakh hectares. The irrigated area and cropping pattern of the state is influenced by the state's segregation into its agroclimatic zones (AP S. , 2020) .The agro climatic zones can be classified as follows:

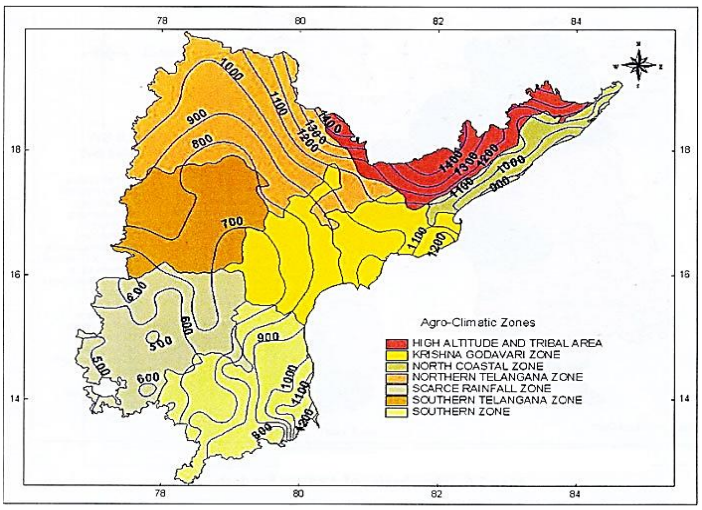
Agroclimatic Zones	Crop Pattern
	***North coastal zone*** - Paddy, Groundnut, Jowar, Bajra, Mesta, Jute, Sunhemp, Sesamum, Black gram and Horticultural Crops.
	Godavari zone and Krishna zone - Paddy, Groundnut, Jowar, Bajra, Tobacco, cotton, chilies, Sugarcane and Horticultural Crops
	Southern zone - Paddy, Groundnut, Cotton, Sugarcane. Millets and Horticultural Crops.
	Scarce rainfall zone - Cotton, Korra, Sorghum, Millets, Groundnut, Pulses, Paddy
	High altitude & tribal areas zone -Horticultural Crops, Millets, Pulses Chilies, Turmeric and Pepper.

Exhibit 21 Agroclimatic Zones[11]

4.3 Ground Water Scenario – Andhra Pradesh

In Andhra Pradesh the available water sources are tanks, tube wells (Ground water), rivers and canals. Amongst the mentioned water sources, ground water is a major source of irrigation for the state.

Ground Water - There are 81 sub basins recognized as accounting units for the groundwater in the state. Their area ranges from 90.65 km^2 to 15699 km^2. They are generally too big for estimation of dynamic groundwater resources. Hence for the estimation of ground water levels, the recommended catchment size of these basins is 300 km^2 (AP G. , 2020) .

The average ground water level for the state in March 2020 is 12.59 m, where as it was 15.24 m during the same period in the previous year and observed a net rise of 2.65 m from the previous year water level. Net fall of 2.19 m is observed from November 2019 average water level and 3.60 m rise from May 2019 water level (AP, 2020) .

[11] Source: AP Socio Economic Surveys 2019-20, Crop Pattern

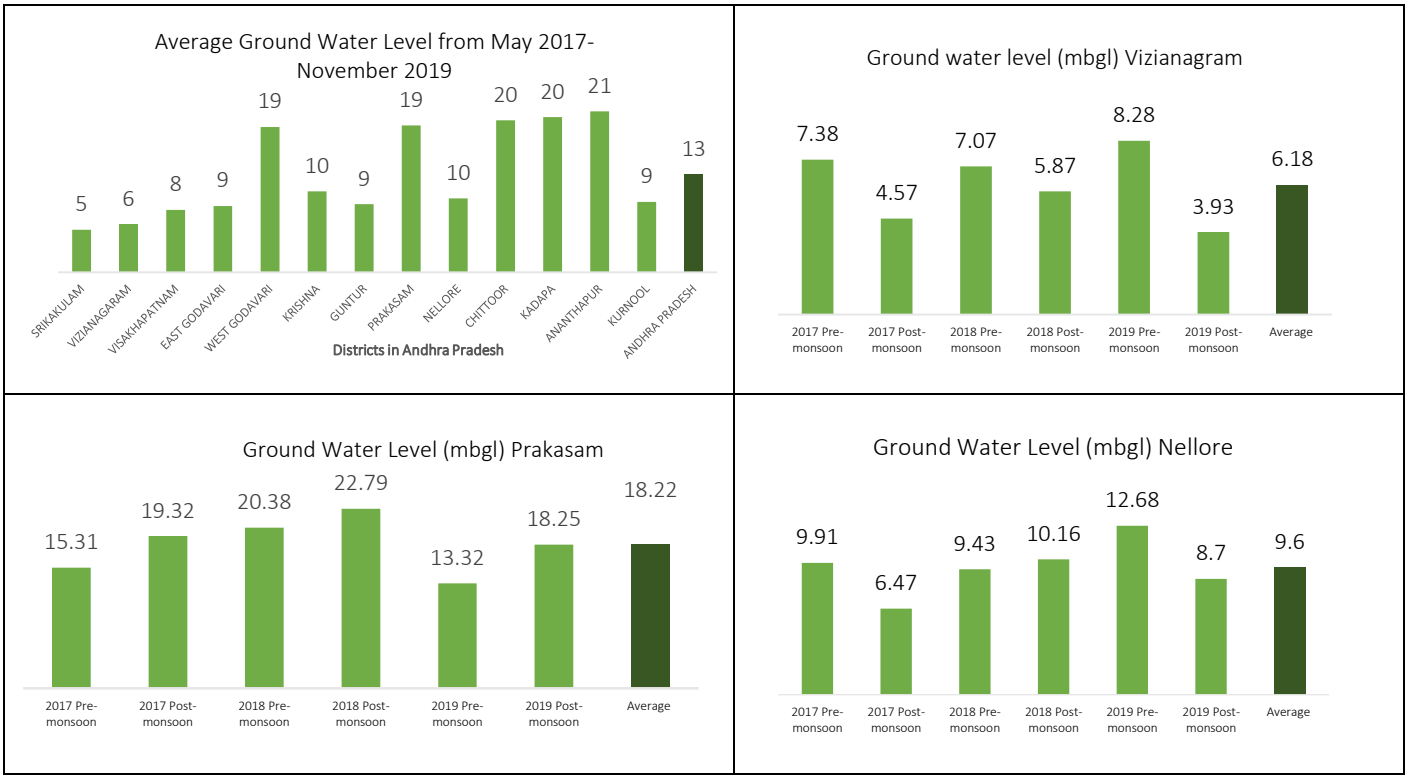


Exhibit 22 Ground Water Level of Andhra Pradesh, Vizianagram, Prakasam and Nellore

Ground Water Recharge in Andhra Pradesh is heavily dependant on the state rivers and its rainfall pattern.

Rainfall - Rainfall is also considered as prime source to recharge ground water levels. The average rainfall pattern in the state lies in between 300 to 400 mm. It is only in the recent past that the state has experienced heavy rainfall during the months of July and August, which has led to the elevation of ground water levels. The rainfall pattern has continued to rise in a positive direction and has helped in the recharge the ground water levels of the state.The variation in rainfall pattern and district level ground water level can be viewed in Annexure -2 of the report.

Rivers - Three of its major rivers contributing as prime sources of water for irrigation are the Krishna, Godavari and Pennar. Apart from these three prime sources, there are 40 rivers in the state that drain directly into the sea (AP G. , 2020) .

4.4 Electricity Scenario of Andhra Pradesh

In the year 2014, Andhra Pradesh was a power deficit state with the supply of almost 22.5 million kWh. Since then due to its accelerated development Andhra Pradesh has become a power surplus state. The growth of electricity consumption in the state is at an average of 9 per cent from financial year 2015-16 to financial year 2018-19. The state's transmission losses are also

determined to be at 3.02 per cent during 2019-20, which is better than the national average of transmission losses at 22 per cent.

100 per cent of the state population is said to have access to electricity and all domestic consumers have access to quality power supply. The per capita consumption of electricity is reported as 1,147 kWh (AP S. , SEO , 2018).

The LT V-Agricultural category places itself as the third largest consumers of electricity amongst the 17 categories catered by the AP DISCOM.The total agricultural services in the state is determined to be 16.97 lakhs with the current installed capacity at 19,160 MW (AP S. , SEO , 2018). Exhibit 23 captures that the agricultural category accounts for around 20 per cent of electricity consumption in the state.

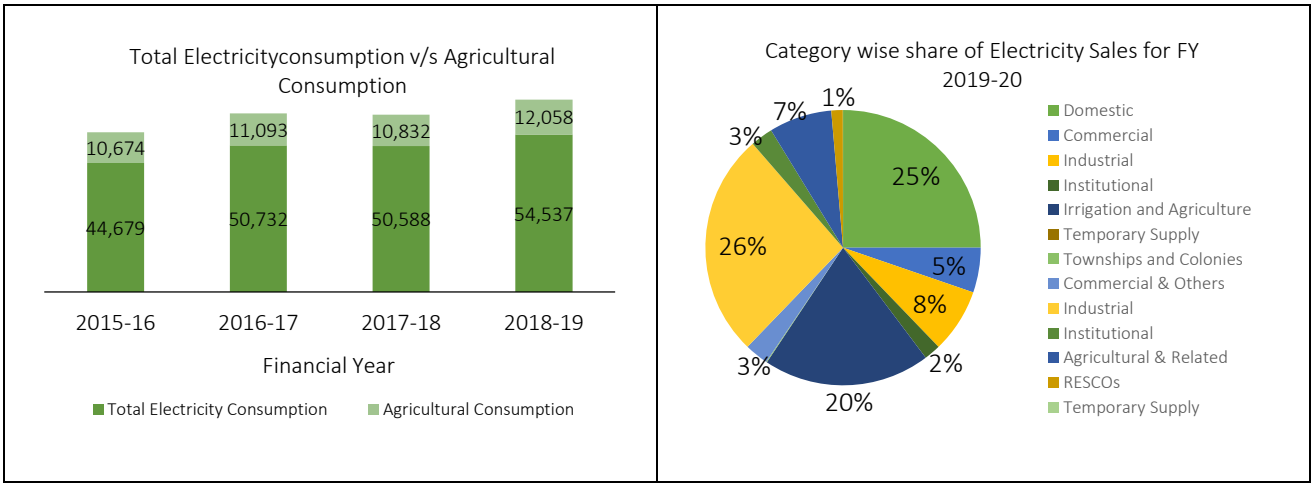


Exhibit 23 Electricity Consumption pattern of Andhra Pradesh (million kWh)[12]

Discussion with the state DISCOM officials also confirmed that the demand in the agricultural category accounts for almost 25 to 30 per cent of the state power consumption. The DISCOM officials also conferred, that consumers in the agricultural category have access to free power supply for 9 hours per day which was increased from 7 hours per day in the year 2019. The consumers have also urged the commission and the DISCOM to further increase the supply to 11 hours per day. The increase in power supply period has led the consumers to use their electrical pump sets at flexible hours, reducing power theft in the state.

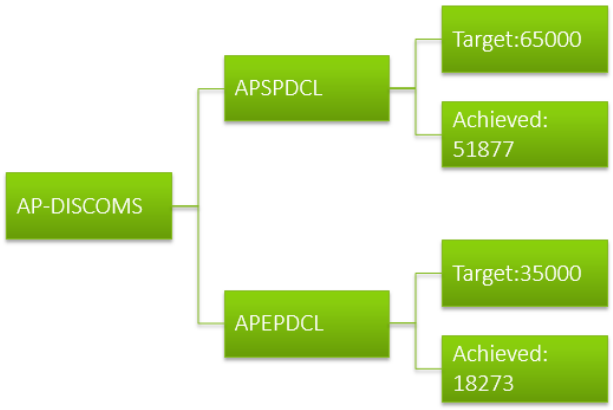
4.5 Scope for scaling up AgDSM program in Andhra Pradesh

Andhra Pradesh has achieved successful implementation of several DSM measures. The Government of Andhra Pradesh with support from its electricity regulatory commission and distribution companies have implemented domestic and municipal street lighting program, replacement of energy efficient pump sets, domestic energy efficient fan program. DSM measures

[12] Source: Retail Supply Tariffs from the year 2015-16 to 2020-21

implemented in the state have helped promote the significance of energy efficiency in industrial, municipal and agricultural category.

In the Present Scenario, as captured in Exhibit 24, the distribution companies have completed almost 70 per cent of the AgDSM program for replacement of agricultural pumpsets with energy efficient pumpsets.



(i) Details of Agricultural pump sets district wise.

APSPDCL Response:

District	No of pump under in HVDS program	Energy Efficient pump sets	solar pump sets
Krishna	40026	9430	2804
Guntur	32299	5424	2221
Prakasam	101868	5722	7762
Nellore	102512	9664	3438
Chittoor	227043	4178	1229
Kadapa	132622	701	468
Anantapur	104770	9176	831
Kurnool	79935	7582	1383
Total	**821075**	**51877**	**20136**

APEPDCL Response: The information is furnished in the following table:

Name of the District	Agricultural Services	Services under HVDS	Energy Efficient Pumps	Solar AGL Pumpsets
Srikakulam	25770	18404	2558	2957
Vizianagaram	31392	23225	5207	4933
Visakhapatnam	30080	27518	4663	2887
Rajahmundry	48734	44694	2973	3940
Eluru	98533	90013	2872	1692
Total	**234509**	**203856**	**18273**	**16409**

(ii) Agricultural services covered under HVDS and no of EE Pumps & Solar pumps proposed to be replaced in FY2020-21 & FY2021-22?

APSPDCL Response: 152400 Nos. pump sets will be covered for the FY 2020-21 & FY 2021-22 and there is no proposal to replace the old pump sets with solar and energy efficient pump sets.

APEPDCL Response: There are no proposals on the points raised by the objector.

Exhibit 24 Current Scenario – Installation of pump sets in Andhra Pradesh[13]

The current pump population in the state is estimated at around 18 lakhs, out of which it is inferred that 15 lakh pumps can be considered as a replacement potential. During the interviews with the program empaneled manufacturers, implementing agency and Installing agency it was confirmed that the average sanctioned load in the state is 5 hp. The DISCOMs in their discussion, mentioned that more than 40 per cent of the existing pump population is rated at 5 hp.

Although the average sanctioned load in the state is 5 hp, the pump replacement potential is inclusive of varied types of models and rated capacities. Rated capacities like 5 hp, 7.5 hp and 15 hp is generally used by the consumers, depending on the ground water level variations and irrigation area. Though there are pumps of varied rated capacities present in the sector, the DISCOM officials have expressed the interest in continuing to replace the pumps rated at 5hp.

[13] Source: Retail Supply Tariffs from the year 2015-16 to 2020-21

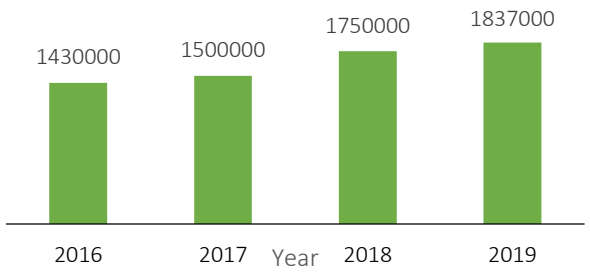
The state's pump population indicated in Exhibit 25 has a growth rate of about 10 percent that concurs with the growth rate of the agricultural consumption of 10 percent.	

Exhibit 25 Volume of Pumps in Andhra Pradesh[14]

APERC is supportive of the program and during the stakeholder consultation to approve the petitions for the AgDSM program, they had deliberated on the following instructions:

1. **Submit a quarterly performance and compliance report** on the implementation of the project
2. The petitioner **shall cause the consumption of energy per feeder per month recorded for the feeders under which it is proposing to replace the old pump sets** with energy efficient pump sets in execution of this order
3. APEPDCL/EESL and APSPDCL/EESL shall **during the first years of implementation conduct quarterly inspection drive on 10 percent** of the EEPS installed in that quarter and submit a report on findings to the Commission and also publish a report in APEPDCL website.

AP DISCOMs have been working towards weighing up the number of drivers against the inhibitors to enhance the awareness of the program and to create better potential to scale up the project. Hence a SWOT Analysis of the ongoing AgDSM program in the state is done to help understand its scope.

Strengths	• A strong support from the APERC has been received for the first phase of the project. • DISCOMs are investing in the development of distribution infrastructure like replacing the DTRs with HVDS in the agricultural category. Replacement of HVDS systems with distribution transformers is estimated at Cr INR 744.50. • Through free repair and maintenance farmers have incurred an average monetary savings of INR 2000 per month. • AP DISCOMs have increased the free power supply from seven hours to nine hours to the agricultural category. This measure has been beneficial to the farmers, as it helps them to operate the pumps at flexible timings. • The energy efficient pump set has been equipped with smart control panel and auto starters. The pump can also be operated with mobile phone applications

[14] Source: Retail Supply Tariffs from the year 2015-16 to 2020-21

	from remote locations. These features have been appreciated by the farmers in the surveyed districts.
Weakness	• Improper metering and calculations for energy savings in agricultural category is a challenge, as timely reporting of the same has not been completed. • Limited awareness regarding water use efficiency and energy efficiency are causing obstacles in the program • Although the DISCOMs have initiated the development in distribution infrastructure, voltage fluctuation experienced on the consumers end is a disadvantage for the program. • The connectivity issue with respect to the smart control panel of the EEPS is a major weakness of the program.
Opportunity	• Tariff rate for the farmer's in LT-V agricultural category is nil. Hence this can be used to encourage the farmers to invest in a new technology instead of providing the EEPS at free of cost. • Also the program can help reduce the state government's subsidy load towards the agricultural category of the state DISCOMs. • The AgDSM program shall be further scaled up considering the 15-lakh pump replacement potential in the state. • Average growth rate of 10% in electricity sales of LT-V agriculture category. • CO_2 emissions have reduced by 109133 tonnes CO_2eq and energy savings of 133 million kWh has been realized through replacement of 74,000 pumps. Hence opportunity of further energy reductions increases through this program.
Threats	• The ongoing Solar pump installation program is being parallelly conducted, to drive the KUSUM scheme launched by the central government.

Exhibit 26 SWOT Analysis for the scope of AgDSM Program in Andhra Pradesh

To scale up the energy efficient pump set program in the state of Andhra Pradesh, three different approaches shall be taken, if the pump replacement potential will be of the capacity, 5 hp. The three different scenarios are as follows:

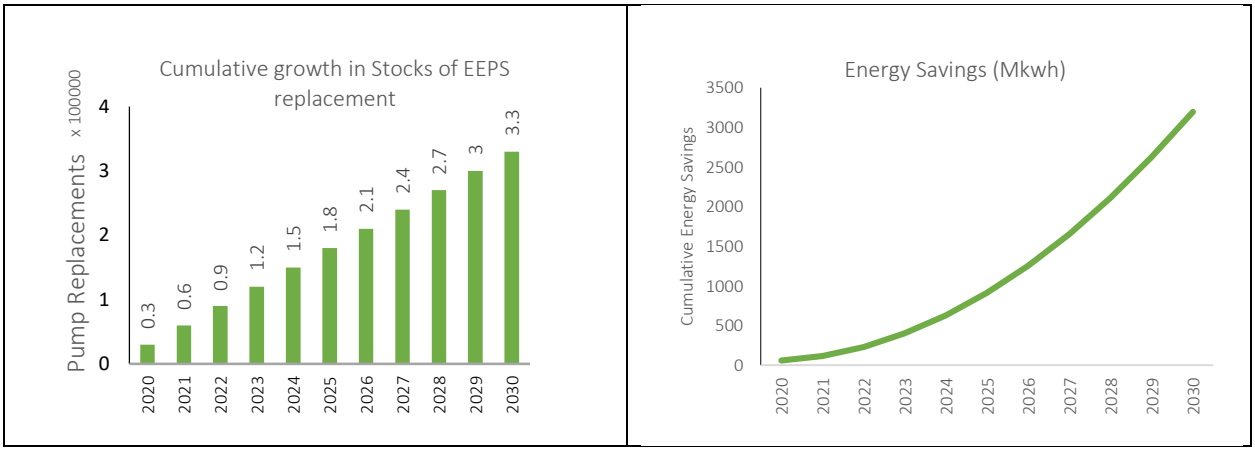


Exhibit 27 Conservative Approach to scale up the EEPS replacement program in Andhra Pradesh

Conservative Approach

Considering conservative **replacement of 30000 pumps per annum** for next 10 years would bring energy savings of 3 billion kWh. It would fetch investment to the tune of 120 Cr per year. The conservative estimate would replace only $1/6^{th}$ of the potential exists in Andhra Pradesh in 10 years.

Further assessing the scale up of pump set replacement in Andhra Pradesh, two other approaches that can be taken are:

Replacing all 15-lakh pump sets in five to six years. This would be an aggressive approach on the government's end. Considering this approach, a total of 3 lakh pump replacements per annum would have to be completed. This would bring in an annual savings of 570 million kWh every year and fetch investment to the tune of INR 1200 crores per year

The intermediate approach would Replace all 15 lakh pumps in 10 years. The Government could also explore this as a less expensive alternates for the pump replacement program. For 100 per cent replacements in the next 10 years, a growth in the replacement rate at 0.4% per annum should be maintained. Adhering to this method, pump replacements in a year would bring in an annual savings of 11 billion kWh every year and fetch investment to the tune of INR 700 crores per year.

5. Scope of AgDSM Program – 3 Key States

5.1 Summary of Findings

After a thorough desk review and few primary stakeholder consultations, the findings reflect a growth in power consumption of agricultural consumers in Telangana, Haryana and Uttar Pradesh. The CEA pump energization reports and the state tariff orders are indicative of growth of pump usage in the agricultural sector.

The volume of pumps in the agricultural category of these states have an average growth of rate of 10 per cent. This volume of pumps lies in a range of few lakhs creating a huge potential for replacements with the new 5 star rated energy efficient pump sets. Majority of these pumps are of the capacity ranging from 5 hp to 7.5 hp, as they are affordable and of smaller capacity.

A SWOT analysis is shown for each state is indicative of the factors that will affect the scope of AGDSM program in these three states reflects. These factors are later explained as in the detailed state findings.

5.2 State Wise findings

5.2.1 Scoping Study for Uttar Pradesh

Uttar Pradesh (UP) is an agrarian state. It caters to almost as 65 per cent of the total population is dependent on agriculture (upagriparidarshi, 2019). Hence the scoping study for UP focuses on the sector's major sources and its probable effect on the AgDSM program:

1. Use of water sources
2. Electricity use in the sector

5.2.1.1 Ground Water Assessment

Uttar Pradesh (UP) lies within the plains of 'Ganga-Yamuna Rivers', which is one of the world's wealthy groundwater reserves. However, over the years to meet the diverse needs of the water in the state, reliability on groundwater resources has increased.

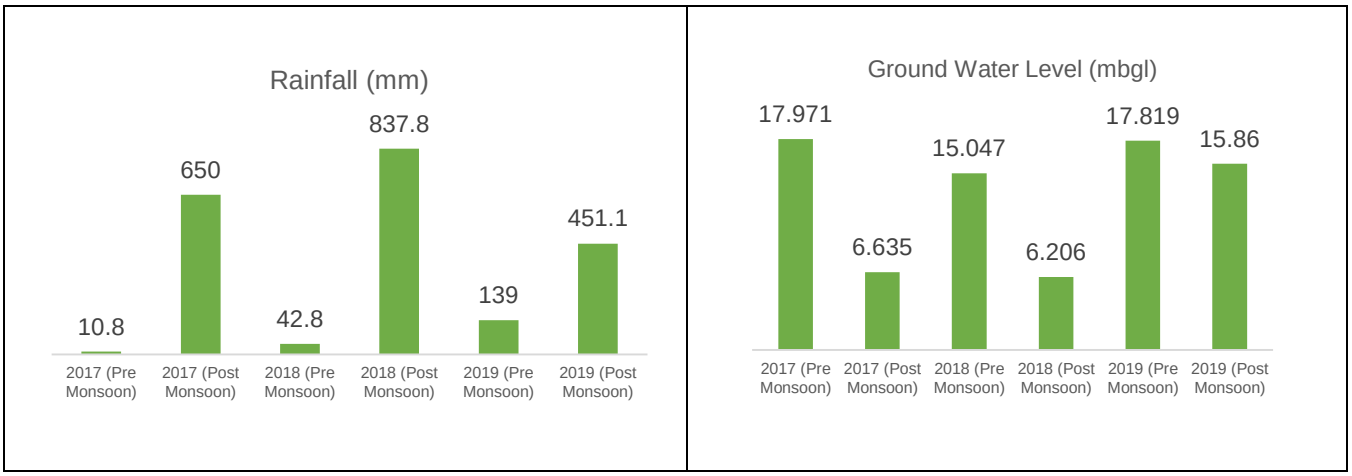


Exhibit 28 Uttar Pradesh's ground water level (mbgl) with respect to rainfall (mm)

UP is known as an agricultural state. Approximately 70 per cent of irrigation in the state mainly relies on groundwater resources (UPGWD 2019). The current scenario for UP ground water level is shown in Exhibit 28.

The average ground water level of the UP lies in between 15-19mbgl. Amongst the 75 districts in UP, Agra is at the lowest ground water level with an average of 28 to 30 mbgl and Gonda district is at the highest ground water level of 2.5 -5 mbgl (UPGWD 2019). Ground water resource has attained a prominent position as prime source of irrigation. Its unlimited and excessive use has led to its over-exploitation and has become common amongst the many rural and urban areas of the state (UPGWD 2019).

Uttar Pradesh's Ground water scenario is indicative of the necessity towards proper ground water management. This shall only be made possible through implementation of the regulation of ground water extraction. Most of the exploitation is based on the tube wells[15] the from small irrigation sector(UPGWD n.d.). Hence it is imperative that proper measures shall be taken into consideration for disseminating information regarding ground water conservation in the state. Measures like rainwater harvesting and proper planning of well installations and monitoring are part of UPGWD's ground water recharge activities and schemes.

Along with ground water recharge the UP government should also create awareness regarding usage of tube wells. Measures like implementation of new technology pumps could be a solution

- Help improve energy efficiency
- Manage exploitation of ground water resources.

[15] There are about 48 million shallow tube wells, 49480 medium tube wells and 33510 deep tube wells and 30917 government tube wells in UP's irrigation sector.

5.2.1.2 Electricity Scenario of Uttar Pradesh

Uttar Pradesh Power Corporation ltd. is responsible for both Transmission and Distribution functions of the state. There are five DISCOMs that cater to the electricity consumers of the state and are governed by the UPPCL.

These distribution companies take cater to the electricity demand and supply for 14 categories of users. They are responsible to determine the scheduled tariff for the consumer categories. These 14 categories have resulted in the growth of electricity consumption of the state by a year-on-year growth rate of almost 12 per cent.

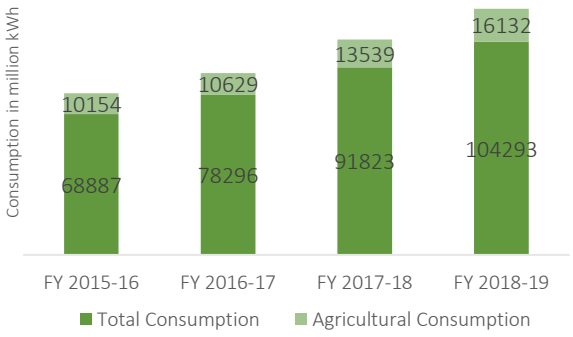
Exhibit 29 shows that Category LMV-5 (agricultural category) accounts for 15 per cent of the state's electricity consumption	

Exhibit 29 Electricity Consumption pattern of Uttar Pradesh[16]

Uttar Pradesh in currently facing an acute power shortage even though there is an increase in the electricity demand. Against the connected load of 13,954 MW the installed capacity is only 5886 MW (8600 MW including the share in the Central sector units). UP has a peak demand deficit of about of 15 per cent while its energy shortage is about 8 per cent (UPPCL, 2020).

One of the major contributors to the demand growth is the increase in electricity consumption by the LMV 5 – Private Tube Wells category of the state. This category incorporates the low tension (LT) agricultural consumers that utilize different sizes of pump sets for irrigation purposes. Currently there is a total of 12,65,806 consumers with a connected load of 68.5 million kW in this category. The connected load consists of new energy efficient pumps and pumps with very old inefficient pump causing unnecessary consumption. The lineage of these old pumps could lie in between 15 to 10 years.

5.2.1.3 Energy Efficiency Initiatives of Uttar Pradesh

Demand side management for electricity scenario has been considered as an energy efficient initiative to curb unnecessary electricity consumption from the consumer end. UPPCL with help of

[16] Source: State Tariff Order 2015-16 to 2018-19

"Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA)" is implementing programs like:

1. Unnat Jyoti by Affordable LEDs and Appliances for All (UJALA)
2. Municipal Demand Side Management Demonstration Program - 4 stretches of Ghaziabad Development Authority have been identified and around 822 streetlights have been replaced by LED Street Lights under this program (UPNEDA n.d.).
3. Agriculture Demand Side Management Program

The AgDSM program is being implemented in UP to help farmers of the category LMV – 5, to reduce electricity consumption and thereby reduction in electricity bill. The AgDSM program in UP has recently implemented the replacement of 9 drinking water pump with Energy Efficient pump under its rural drinking water pumping system scheme. Apart from the rural drinking and water scheme the GoUP has also undertaken an initiative of replacing 9000 agricultural pumps set with 5 hp energy efficient pump sets (UPNEDA n.d.).

According to the pump energization reports from central electricity authority the pump volume available in the state is more than 12 lakhs and the yearly growth of the volume can be seen in Exhibit 30.

Exhibit 30 shows that yearly there is an addition of almost one lakh new pump set in the state, with a growth rate of 5.5 per cent every year.

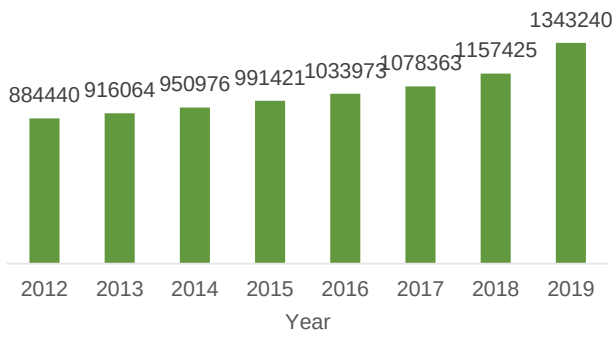


Exhibit 30 Volume of Pumps in Uttar Pradesh (Nos.)[17]

GoUP in collaboration with EESL has launched the Kisan Urja Daksh Pump Yojna (Kisan Uday) under Agriculture Demand Side Management (AgDSM) Program in the state in the year 2017 (GoUP & EESL 2017).

- Under this scheme farmers of the state will receive 9000 energy efficient pumps in the first phase and 10 lakhs pump sets in the second phase
- Government of Uttar Pradesh to distribute the energy efficient pumps to farmers free of cost under the Kisan Urja Daksh Pump Yojna

[17] Source: CEA Pump energization reports

In this scheme, Farmers will be provided with 5 years free repair and maintenance leading to potential cost saving of Rs. 10,000 – Rs. 12,000. Additionally, the farmers will also save on the electricity bills by using these energy efficient pumps apart from reducing the energy consumption in the state (GoUP & EESL 2017).

When consulted with EESL, it was informed that the program was being financed with the help of NTPC CSR initiative. The implementation of pump replacement is done with farmer's consent and their willingness towards the new technology. EESL officials confirmed that a total of 3856 energy efficient pump sets with smart control panels are replaced, and the target date of project completion is March 2021. EESL has confirmed that the state has replacement potential of 10 lakh pumps with the highest sanctioned load of up to 30hp.

Considering the current pilot project being implemented it can be inferred that the project is being pursued with positive determination of UPPCL and GoUP. The state looks forward to replacing 10 lakh pumps by 2022 which is estimated to reduce the peak load by 3550 million kWh (UPPCL , 2019). The report also states that the replacement potential of the state's irrigation pump sets shall be determined post an impact assessment of the ongoing pilot project. Hence it can be said that the further scope of deployment for energy efficient pump sets heavily depends on the success of the pilot project.

The following steps reported in UPERC's tariff order of 2018-19, is an indicative of the efforts by the commission and DISCOM, to encourage usage of energy efficient pump set.

The steps reported were:

1. Reduction in the electricity tariffs for energy efficient pump set users from INR 2 per kWh to INR 1.65 kWh.
2. Proposal for mandatory provision of energy efficient pump sets for consumers requesting for new connections

Strength	Weakness
• EESL in Uttar Pradesh is conducting a pilot project to implement the EEPS program under initiative called the *Kisan Urja Daksh Pump Yojna* The replacement is implemented under the CSR investments by NTPC. 2400 pumps have already been replaced under this program. • They are also provided nine hours of free power supply.	• The replacement program is restricted to only 5 hp pumps • The varied ground water levels may lead to incorrect assessment of capacity of pump set, during the replacement program. • The states distribution infrastructure could cause voltage fluctuations and might affect the operation of the replaced pumps.
Opportunity	**Threat**
• Agricultural category in UP accounts for 15 per cent of the state's electricity consumption.	• The ongoing Solar pump installation program is being parallelly conducted, to drive the

• State's Pump replacement potential is ten lakhs. • The tariff for agricultural category is 2 Rs/kWh for normal users and 1.65 Rs/kWh for farmers using EEPS. This shall encourage use of EEPS at the consumer end. • UP DISCOMs in their recent tariff orders have implied the supply of energy efficient pump sets while providing new electrical connection to farmers. This would help construct an easy path to implement the EEPS program in UP.	KUSUM scheme launched by the central government.

Exhibit 31 SWOT Analysis for Uttar Pradesh

5.2.2 Scoping Study for Haryana

According to the Indian Council of Food and Agriculture, 44.69 per cent of Haryana's population is dependent on agriculture. Hence the scoping study to replace irrigation pump sets in Haryana becomes imperative as pump sets used for agriculture is the prime reason to exploit two primary resources: ground water and electricity. Hence further sections would detail findings of the impact on the water use efficiency and energy efficiency of the sector.

5.2.2.1 Ground Water Assessment

Haryana is a water deficit state with respect to surface and ground water resources. The state is sub-divided into nine physiographic units and is drained by two major rivers Ghaggar and Yamuna. The river Yamuna defines its eastern border with Uttar Pradesh (CGWB 2016). The average ground water level of the state lies in between 10 mbgl to 16 mbgl.

The inadequate recharge of the ground water is due its erratic rainfall pattern over the years. It also depends on cultural practices such as continuous puddling in rice crop and compaction due to pass of heavy machinery. With the disturbing equilibrium of subsurface hydrological regime, the ground water resources in the state continues to degrade (HAU 2018).

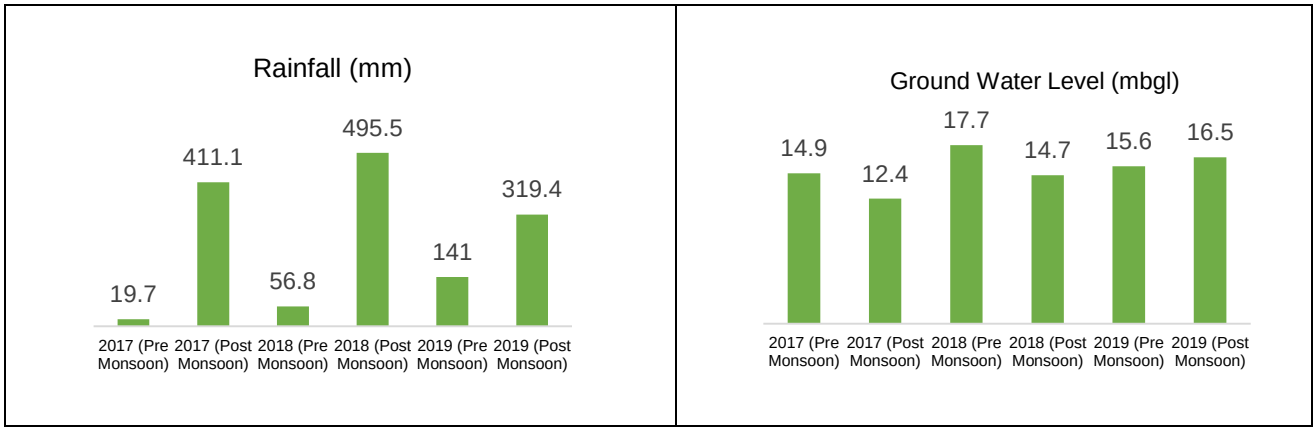


Exhibit 32 Haryana ground water level (mbgl) with respect to rainfall (mm)[18]

[18] https://indiawris.gov.in/wris/#/groundWater

The tremendous development of surface irrigation resources since the promotion of Haryana state is a major reason for this over exploitation of ground water.(HAU 2018) This development in the irrigation resource is due to the agriculture sector becoming a leading occupation for residents of the state. They are equipped with flat arable land irrigated by submersible pumps and an extensive canal system.

The four irrigation systems in the state are:

1. Western Yamuna canal
2. Bhakra canal
3. Agra canal
4. Ghaggar canal

Haryana has 0.72 million ha available ground water of which 0.65 million ha is utilizable for irrigation in net return (90%). (GWC 2018) The state's water potential has depleted due to over exploration by large number of shallow and deep tube wells at an average of 14 tube wells/km^2. This has led to continuous decline in water table. (GWC 2018)

Exhibit 32 provides a clarity on the high decline in ground water table of the state. The increasing demand and scarcity of Ground Water Resource underlines the importance of Artificial recharge and water conservation. (GWC 2018)

In terms of agricultural products, the constant rice wheat cropping system and heavy-duty crop like sugarcane is mainly responsible for the drafting of ground water. The cultivation of additional rice crop and early transplanting of main rice in some area has further aggravated the situation (HAU 2018).

5.2.2.2 Electricity Scenario of Haryana

The distribution companies of Haryana take into consideration, the electricity demand and supply for 11 categories of electricity consumers. The energy availability and supply[19] reported in the 2018-19 annual report from HERC, is an indication that the state can meet the high demand of electricity at the consumer end.

The 11 categories have resulted in the year-on-year growth rate of almost 12 per cent of electricity consumption of the state. The state's major consuming categories are the HT Industry, domestic category and the agricultural category. Exhibit 33 captures a year on year growth of 19.5 per cent in the state's electricity consumption.

One of the major contributors to this growth of electricity consumption is the agriculture sector (sixth category of consumers in Haryana). This category incorporates the LT consumers that utilize different sizes of pump sets for irrigation purposes. When 2.404 per cent of growth in the

[19] Both availability and demand are 53,665 million kWh

electricity consumption load was considered, the sale figure of agriculture pump-set consumers was hiked to 9575 MU in FY2018-19 (HERC 2019). Energy efficiency measures considered by the Haryana DISCOM's are explained in the further section.

Exhibit 33 shows that the agricultural category, which is the third largest electricity consuming category in the state, accounts for 21 per cent of the state's electricity consumption

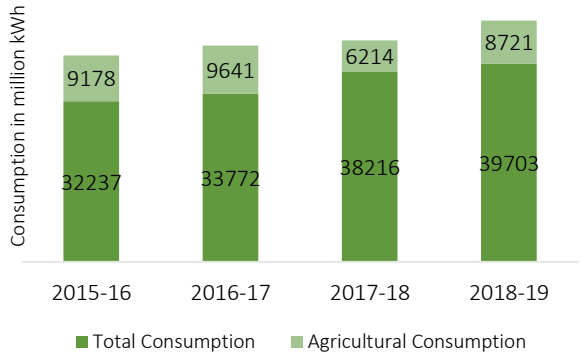


Exhibit 33 Electricity Consumption pattern of Haryana (million kWh)[20]

5.2.2.3 Energy Efficiency Initiatives of Haryana

Haryana Renewable Energy Development Agency (HAREDA) and Haryana State Electricity Regulatory Commission (HERC) have been focusing on DSM programs like energy conservation in industries, energy efficient lighting and energy efficient buildings.

Along with the several other DSM programs, Haryana distribution companies are offering farmers energy efficient pump sets at a cost, to reduce the agricultural category's electrical consumption. DHBVN Sales Circular No. D/10/2019 mentions "New tube well applicants shall mandatorily install 5 star rated energy efficient pump sets with smart control panel which shall be procured by the firm empaneled by the Nigam." This initiative has resulted in a demand of 89000 new connections from the user end.

DHBVN and UHBVN has empaneled several pump manufacturers to supply a total of 29000 pump sets, of capacities varying from 3 hp to 30 hp. The circular also states that the pump sets to be supplied will be of mono-block and submersible type. This is a different approach when compared to other states as their AgDSM program concentrates on replacing only submersible type pump sets. The DISCOMs have also requested for a deposit for INR 30000 per EEPS as a consent deposit from the farmers. During a stakeholder consultation with the DISCOM officials, they mentioned that up to 8000 pump sets have been added in the category. They mentioned that the program has currently hit a roadblock, due to the unavailability of the updated BEE 5 star rated labelled pump set in the market.

[20] Source: State Annual Report of HERC from 2015-16 to 2018-19

The DISCOM officials also explained, that the average sanctioned load of the state's agricultural category is 10 hp and the highest is 60 hp, which is concomitant to the state's varied ground water structure.

The State of Haryana has a pump replacement potential that lies between 6 to 6.5 lakhs. Considering the pump volume growth rate of 2.7 per cent, the volume is estimated at 821399. Exhibit 34 captures the picture of growth in tube well across the state of Haryana which concurs with the load growth of 2.4 per cent in agricultural electricity consumption.

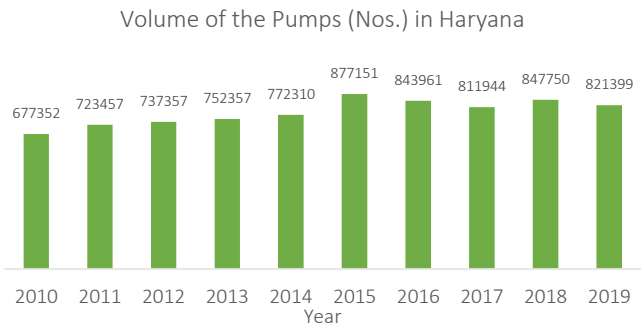
Exhibit 34 is indicative of the pump population in Haryana, where the annual growth of the population is at the rate of 2.3 per cent	

Exhibit 34 Volume of Pumps in Haryana[21]

Strength	Weakness
• Haryana DISCOMs in 2019 have initiated the supply of 29000 energy efficient pump sets (ranging from 5hp to 20hp) to farmers requesting for a new connection. (DHBVN, 2019). Around 8000 pump sets have already been supplied to the farmers. • The EEPS addition program has resulted in demand for 89,000 new connections from the farmers. This initiative reflects the State's interest in improving the energy consumption scenario for the agricultural category. • With tariff for agricultural category (INR/kWh) at nil, the program could be introduced at an investment cost from the consumer end.	• Limited awareness of water use efficiency and energy efficiency amongst the farmers. • Pumping systems as claimed by the ground water department is one of the main reasons for the exploitation. Hence the pump capacity of higher ratings, leading to higher than expected consumption would be considered as a drawback of the program. • Unavailability of the new BEE 5 star rated pump set in the market, due to its continuous update in the efficiency ranges.
Opportunity	**Threat**
• Agricultural category, which is the third largest electricity consuming category in the state, accounts for 21 per cent of the state's electricity consumption. • The state has the pump replacement potential of almost five lakhs.	• The ongoing Solar pump installation program is being parallelly conducted, to drive the KUSUM scheme launched by the central government.

Exhibit 35 SWOT Analysis for Haryana

[21] Source: http://esaharyana.gov.in/en-us/State-Statistical-Abstract-of-Haryana

Option for the scope of AgDSM in Haryana - The replacement program of five lakh pumps in Haryana can be completed over a period of ten years. The approach shall be feasible considering that, 50,000 pumps shall be replaced per year starting in the year 2021. The replacement program would incur an investment of almost 450 crores INR per annum and resulting in the yearly energy savings of 95 million kWh.[22]

5.2.3 Scoping Study for Telangana

A scoping study for Telangana is also conducted to assess the potential replacements of agricultural pump set. The scoping study conducted is on the similar line to that of UP and Haryana.

5.2.3.1 Ground Water Assessment

Since its inception in 2014 the State of Telangana is committed towards becoming self-sufficient to access varied water resources.

It is situated at the southern stretch of Indian Peninsula and is endowed with 40 major and minor rivers. The rivers Godavari and Krishna are the two most significant rivers amongst them catering to most of its infrastructural and agricultural water needs. Godavari with its tributaries Pranahita, Manjeera, Maneru, Indravati, and Kinnerasani drains through the northern parts of the state. Krishna with its tributaries Tungabhadra, Bhima, Musi, Paleru and Munneru flows through the southern parts of the state. These rivers with their tributaries are the two main water resources of the state. They are further being used to develop artificial canal systems to provide water to farmlands of the state.

Similar to other agrarian states, Telangana also depends on harnessing conventional sources like the ground water resource for irrigation purposes. In Telangana, out of 14.85 lakh hectares of net irrigated area is irrigated with ground water (SEO 2015).The ground water levels of the state is adequate in all its 33 districts as reported in the year 2020. As captured in Exhibit 36 it can be derived that the state's average ground water level lies between 6 to 14 mbgl.

The state has also experienced excess rainfall in the years 2019 and 2020 which has led to a rise in the state's average ground water level. In May 2019, the ground water department of Telangana reported that, *"The District wise average water levels range from 7.58 mbgl in Wanaparthy to 26.47 mbgl in Medak with State average of 14.55 mbgl."* Whereas in the In November 2019, **"***The District wise average water level varies from 3.32 mbgl Warangal (U) District to 16.89 mbgl in Sangareddy District with state average of 7.53 mbgl."* (GWD 2019).

[22] These values have been derived assuming the investment value and energy savings per annum that were derived for the state of Andhra Pradesh.

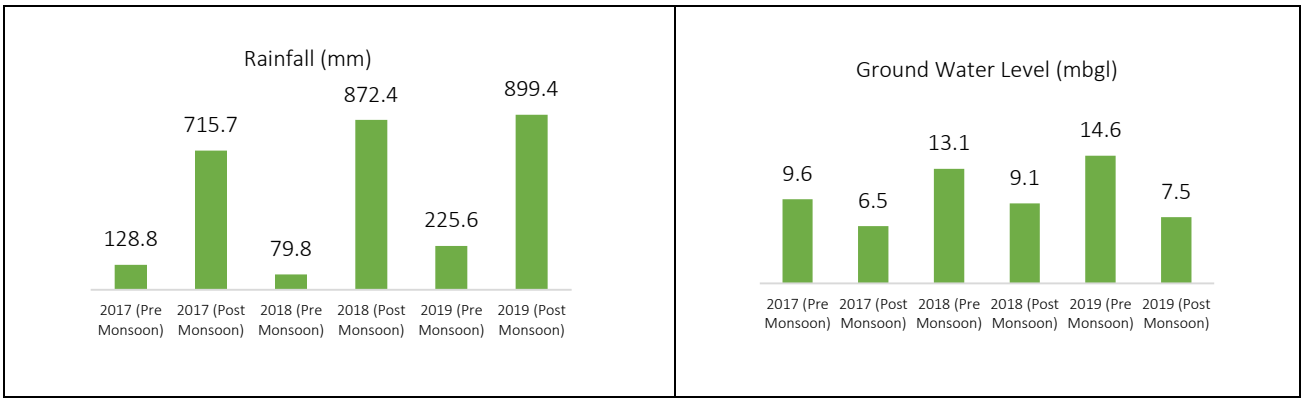


Exhibit 36 Telangana ground water level (mbgl) with respect to rainfall (mm)[23]

Apart from the increase in rainfall as a source of recharge of ground water of the state, the state has also initiated flagship programs like Mission Kakatiya, that help restore small irrigation tanks in the state. This initiative helps utilization of available surface water in conjunction with ground water to bridge the potential gap of the untapped irrigation potential of the stat (SEO 2020).

5.2.3.2 Electricity Scenario of Telangana

As soon as the bifurcation took place, the State Government focused on ensuring that the state becomes self-sufficient in power. Hence the Telangana State Electricity Regulatory Commission (TSERC) was constituted on 3rd November 2014. Post implementation of the reorganization act, the activity of distribution and retail supply of power was entrusted to the following distribution companies:

1. TSSPDSL – Southern Power Distribution Company of Telangana ltd.
2. TSNPDSL – Northern Power Distribution Company of Telangana ltd.

These distribution companies take into consideration, the electricity demand and supply for 16 categories of consumers. These 16 categories have resulted in the year-on-year growth rate of almost 11 per cent of electricity consumption of the state. The state's major consuming categories are the HT Industry, domestic category and the agricultural category. Exhibit 37 shows a growth in the state's electricity consumption.

The state DISCOMs currently provides 24x7 power to all sectors including free 24x7 power to agriculture. Telangana is the only state in the country, which has the distinction of offering 24x7 power supply to agriculture serving 24.16 lakh farmers. This enhanced supply of quality power has enabled farmers to irrigate their farms at their desired timing. The certainty of having quality continuous power supply significantly boosted the economic opportunities for all sections of the population (SEO 2020).

[23] Source: https://indiawris.gov.in/wris/#/groundWater

From financial year 2014-15 and 2017-18, power consumption in the agricultural category has increased from 1.98 to 3.35 kW/ha. This is majorly due to the advancement of farm mechanical equipment. The power availability in the Telangana State is said to be higher than the national average of 1.35 kW/ha and it is projected to increase to 3.5 kW/ha by 2024 (SEO 2020).

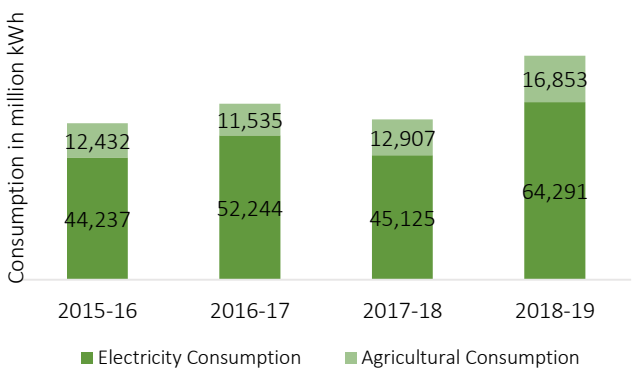
Exhibit 37 shows that the agricultural category accounts for 26.2 per cent of the state's electricity consumption.	

Exhibit 37 Electricity Consumption pattern of Telangana (million kWh)[24]

5.2.3.3 Energy Efficiency Initiatives of Telangana

Electricity demand reduction has been the focus of TSERC since its inception. When enquired regarding the energy efficiency measures in the state during the released of its first Retail Supply Tariff of 2015-16, TSSPDCL response, stated the replacement of incandescent bulbs with CFL bulbs under the Bachat Lamp Yojna scheme.

The State electricity regulatory commission, since then has continued to remain stringent with respect to energy conservation measures for the state. The 24 X 7 power supply to all its category, is one of its regulatory push towards demand side management (DSM), as it would help avoid un-metered and illegal connections, especially in the agricultural category. As mentioned earlier this measure has also helped improve the quality of power.

To maintain the quality of power and demand from the farmer's the state distribution utilities have pursued replacement of older distribution transformers (DTRs) to more robust High Voltage Distribution systems. Installation of HVDS in multiple locations have proven to provide wider and more stable voltage profiles, leading to stability in power fluctuations and reduction in pump breakdowns.

In its latest Retail Supply Tariff of 2018-19, TSERC has committed to the following DSM measures for LT V- Agricultural Category:

[24] Source: State Annual Report of HERC from 2015-16 to 2018-19

1. DSM Measures includes frictionless foot valve, capacitor of adequate rating, HDPE or RPVC piping at suction and/or delivery and ISI marked mono-block or submersible pump set.
2. All new connections shall be given only if the farmer uses a five (5) star rated pump and complies with the DSM measures and with meters (TSERC 2019).

These measures are an indication towards the creating awareness of energy efficiency amongst farmers and their behavior towards operation of agricultural pump sets. Currently 3.31 lakh agriculture pump sets in Telangana state amongst the 24.16 lakh Agricultural connections has access to 24 hours power supply. The state is hopeful that in combination with investments for energy efficiency measures of the lift irrigation schemes, the agriculture sector can enhance productivity and farm incomes significantly (SEO 2020).

Exhibit 38 captures data of pump volume for only four years, indicating an average growth of 8 per cent every year.	

Exhibit 38 Volume of Pumps in Telangana[25]

Exhibit 38 is an indication of the pump population in the state, catering to the irrigation and drinking water supply of the state. These pumps are inclusive of all models of pumps, namely, monoblock and submersible. The average sanctioned load of agricultural pump sets is around 10.5 hp, with the highest load at 30 hp. Although the average sanctioned load is around 10.5 hp, multiple manufacturers agree that tube wells catering to irrigation needs of individual farmers can be switched to 5 hp or 7.5 hp. This measure would be dependent on the ground water structure of the district. Districts with lower ground water levels i.e. 30 mbgl, could utilize the lift irrigation scheme being implemented by the state government.

Strength	Weakness
• Telangana is implementing several measures to improve energy consumption scenario for the agricultural category. In their tariff order of 2018-19 they state the following the implementation of 24 hours power supply to agricultural services, the	• Telangana DISCOMs are promoting energy efficiency programs in the lift irrigation category, especially to replace high capacity lift irrigation pumps. These

[25] Source: http://esaharyana.gov.in/en-us/State-Statistical-Abstract-of-Haryana

Strength	Weakness
farmers can pump water at any time of the day, and it is expected that they will judiciously pump water as per requirement resulting in lower consumption of electricity. • As implied in tariff orders 10 per cent of existing pump population has been replaced by the EEPS as implied in state tariff orders. • Agricultural category accounts for 26.2 per cent of the state's electricity consumption • The state DISCOMs have pursued replacement of older distribution transformers (DTRs) to more robust High Voltage Distribution systems.	pumps can also be utilized to irrigate fields with lower ranges of pump set. • The connectivity issue with respect to the smart control panel of the EEPS is a major weakness of the program
Opportunity	**Threat**
• 3.31 lakh agriculture pump sets in Telangana state out of 24.16 lakhs Agricultural connections has access to 24 hours power supply. • New EEPS replacements can be introduced to these connections.	• The ongoing Solar pump installation program is being parallelly conducted, to drive the KUSUM scheme launched by the central government. • The state's average ground water level lies between 6 to 8 mbgl. • The ground water of the state is heavily exploited due to irrigation tube wells.

Exhibit 39 SWOT Analysis for Telangana

5.2.3.4 Option for the scope of AgDSM in Telangana - The replacement program for AgDSM in Telangana shall be limited to only ten lakh pumps. As complete replacement of 22 lakh pump volume present in the state over a period of ten years would be too ambitious.

The approach shall be feasible considering that 100,000 pumps shall be replaced per year starting in the year 2021. The replacement program would incur an investment of almost 890 crores INR per annum and resulting in the yearly energy savings of 190 million kWh.[26]

5.3 Summary

Every year implementation plan of energy efficient pumps for the next 10 years is given below:

Sl.no	State	Volume of pumps per year	Potential savings per annum million kWh	Investment in Cr
1	Andhra Pradesh	30,000	53	260
2	Uttar Pradesh	100,000	355[27]	890
3	Haryana	50,000	95	450
4	Telangana	100,000	190	890

[26] These values have been derived assuming the investment value and energy savings per annum that were derived for the state of Andhra Pradesh.

[27] Reported by UPPCL – 2018-19

Annexures

Annexure -1

List of Stakeholders for the Impact Assessment

1. Farmers of Andhra Pradesh (Beneficiaries)
2. State DISCOMs
3. Pump manufacturers
4. Pump installing Agencies
5. Local Service Engineers (Manufacturer's service engineers)
6. Energy Efficiency Services Limited
7. EESL State officials
8. KfW Team

Annexure -2

Sample Survey Questionnaire [28]

Questionnaire for Stakeholders: Category- Beneficiaries

Agricultural Demand Side Management (AgDSM) Program

Beneficiary's Personal Details:

1. Beneficiary's Name:

2. Address:

   Village- Taluka-

3. Gender:

   ☐ Female ☐ Male

4. Age

   ☐ 18-30 ☐ 31-45 ☐ 45-60 ☐ Above 60

5. What is your Education qualification?

[28] Questionnaire is subject to change as per progress review meetings for the program

☐ HSC and Below ☐ HSC
☐ Graduate ☐ Postgraduate

6. Dwelling Details

☐ Own House ☐ Rented House
☐ Own Vehicles (e.g. Car, Trucks, Tractor)

Beneficiary utility billing details:

(Collect copy of electricity bill for further analysis and documentation purposes)

1. Consumer NO. (K No.) : _____
2. Sanction load: _____kVA/kW
3. Connect load details: _____kW
4. Current power factor: _____.

Agricultural Land Details:

1. What is the size of your Agricultural Land (in acres)? _____
2. What type of farming is done on your land?

☐ Conventional Method ☐ Centre Pivot Irrigation
☐ Drip Irrigation ☐ Sprinkler irrigation
☐ Sub-Irrigation ☐ Lateral move irrigation

3. If Conventional Method, Please specify: _____
4. If Sprinkler irrigation, number of sprinklers currently running in the farm_____

5. How far is the pump located from the actual point of use: _____

6. Please Mention the crop pattern of your land in an year:

Before installing EEPS:

Months	Crop 1	Crop 2	Crop 3
May - July			
July –October			
October - December			
February to April			

After Installing EEPS:

Months	Crop 1	Crop 2	Crop 3
May - July			
July –October			
October - December			
February to April			

7. Crop yield
   - Before EEPS: _____per acre
   - After EEPS: _____per acre

8. Has the yield on land increased, after installation of the EEPS?

☐ Yes ☐ No

Pump Design Details:

Design detail parameter	Values		
	Pump 1	Pump 2	Pump 3
1. Pump rating (kW)			
2. Date of Pump Installation			
3. Acreage under Pump (acre) – OLD Pump			
4. Acreage under Pump (acre) – New Pump			
5. Depth of the Pump Installation – OLD Pump			
6. Depth of the Pump Installation – New Pump			

7. Depth of water table – Old Pump			
8. Depth of water table – New Pump			

Pump Operating Details:

1. Total number of pumps operating in farm : _____
2. Total pump operating time before installing EEPS in one day? (Hours/day)

☐ 0-5 ☐ 5-10 ☐ 10-24 ☐ 24

3. Total pump operating time after installing EEPS in one day? (Hours/day)

☐ 0-5 ☐ 5-10 ☐ 10-24 ☐ 24

4. What is the operating cost of the pump per month?

Old Pump: _____
EEPS: _____

5. Does the pump often switch off due to voltage fluctuations?

☐ Yes ☐ No

6. How many times has the new pump set stopped (approximately) in a day while in operation?

_____

7. Do you get immediate response in-case of stoppage of the pump?

☐ Yes, the response is immediate
☐ No, the service person takes time to arrive as he stays far away
☐ No, I find it difficult to lodge the complaint

8. In case of stoppage, which ways are preferred to lodge complaint?

☐ Call Local Electrician

☐ Contact Pump Manufacturer
☐ Contact EESL helpline
☐ Contact DISCOMs

9. In how many days does the pump get repaired after lodging a complaint?

☐ <3 days ☐ 3 to 5 days ☐ 5 to 10 days ☐ >10 days

10. What volume of water is pumped during the operating hours of the pump?

☐ Exactly as required ☐ Surplus water pumped
☐ There is a shortage in the water pumped

11. In case of surplus water pumped out, what do you do?

☐ Store the water in the tank ☐ Share with other farmlands
☐ Nothing the water goes to waste

12. Do you use the Smart Control Panel with the EEPS installed at your site?

☐ No, I don't understand how to use it
☐ No, there is connectivity issues
☐ Yes, it has made operating the pump easy
☐ It is not useful as the requirement of water for the land is to be manually monitored

13. Have you received any training related to the following?

EEPS Standard Operating Procedure ☐ Yes ☐ No

1
2
3

Smart Control Mobile App Handling Guidance ☐ Yes ☐ No

1
2
3

Service Request Call Setup Instructions ☐ Yes ☐ No

1
2
3

Other, if any?_____

1
2
3

14. Has the water and energy saving increased?

☐ Yes ☐ No

15. How far is the nearest service center from your location? _____

16. Has your annual income increased after the installation of EEPS?

☐ Yes, it has increased ☐ No, it remains the same
☐ No, it has reduced

17. How did you receive information about the scheme?

☐ Word of mouth (Specify: Friends/Family) ☐ Panchayat
☐ TV advertisements ☐ Newspaper
☐ Government channels ☐ Seminars, marketing materials

18. Have you completed the repayment for EEPS system?

☐ Yes ☐ No

19. How would you rate your satisfaction with overall scheme and support?

☐ Not satisfied
☐ Satisfied

☐ Very satisfied

20. Which complaints are most prominent? (E.g. pump or panel not working, sim card not recharged, continuous pump shut down, etc.)

    _____

    _____

21. Rate your confidence to participate in any other innovative technology implementation project with the help of government? (1= least useful – 10 = Most Useful)

1	2	3	4	5	6	7	8	9	10

22. Any comments, observations or suggestions for overall scheme?

    _____

    _____

    _____

    _____

Note: *In case Pump is not operational at the time of the survey, please note down the reason

Signature

Date & time

Consultation points for implementing agency:

1. What were the Greenfield parameters considered before the implementation of the Project?
2. What were the results of the willingness form circulated amongst the Farmers during the time of EEPS installation?
3. Cumulative pump-set installations under AGDSM?
4. Type of pumps replaced and respective ratings. How many old pumps were collected in order to replace with new pumps?
5. What was the energy sharing ratio between EESL and DISCOM?
6. What is the repayment period considered in program? Any area wise changes?

7. How much period is required to implement the program district wise in Andhra Pradesh?
8. What was the target percentage energy savings (%) through implementation of the program with respect to baseline?
9. According to the Master Data available on the AgDSM software, what is the current Energy Consumption Status of the EEPS?
10. How many Trainings and awareness programs have been held in the state for the beneficiaries?
11. What were the key challenges faced during different stages design and implementation of program?
12. Overall project cost to understand the economic conditions.
13. Were there any other surveys conducted regarding the implementation of EEPS System? What were the results of the same?
14. How many complaints in average have been registered by the AgDSM Call Centre in EESL with regards to the EEPS?
15. What type of trainings were conducted for the third-party agencies for the Repair and maintenance activities?
16. Who will have the ownership of EEPS after completion of repayment period is over?
17. What are the challenges faced for smart panel connectivity e.g. sim card not recharged?
18. Which type of agreement was signed in between the DISCOM and EESL for Return on Investments? For e.g. shared savings, guaranteed savings, etc.

Questionnaire for DISCOMs:

(Some of questions are based upon the query raised by the APERC)

1. What power quality issues and challenges faced by DISCOM prior to the AgDSM program?
2. What is rate of transformer failure and/or transformer loading instances?
3. What is the monthly maximum power demand during peak hours? Any changes in peak load consumption?
4. Any variation in cumulative demand after installation of EEPS?
5. Any changes in power consumption pattern due to adoption of EEPS?
6. What is the percentage deviation in power forecast and actual demand before and after installation of EEPS?
7. Do you think statewide AgDSM program can reduction the deviation settlement mechanism cost for DISCOM?
8. What types of awareness programs were held for the Farmers, in relation to the EEPS?
9. Any M&V audits were conducted post installation of EEPS in the selected areas? What are the findings in relation to energy savings after M&V audits?
10. How many AgDSM program Quarterly Performance reports were submitted to the ERC? Can you provide the copy of the performance reports if available?

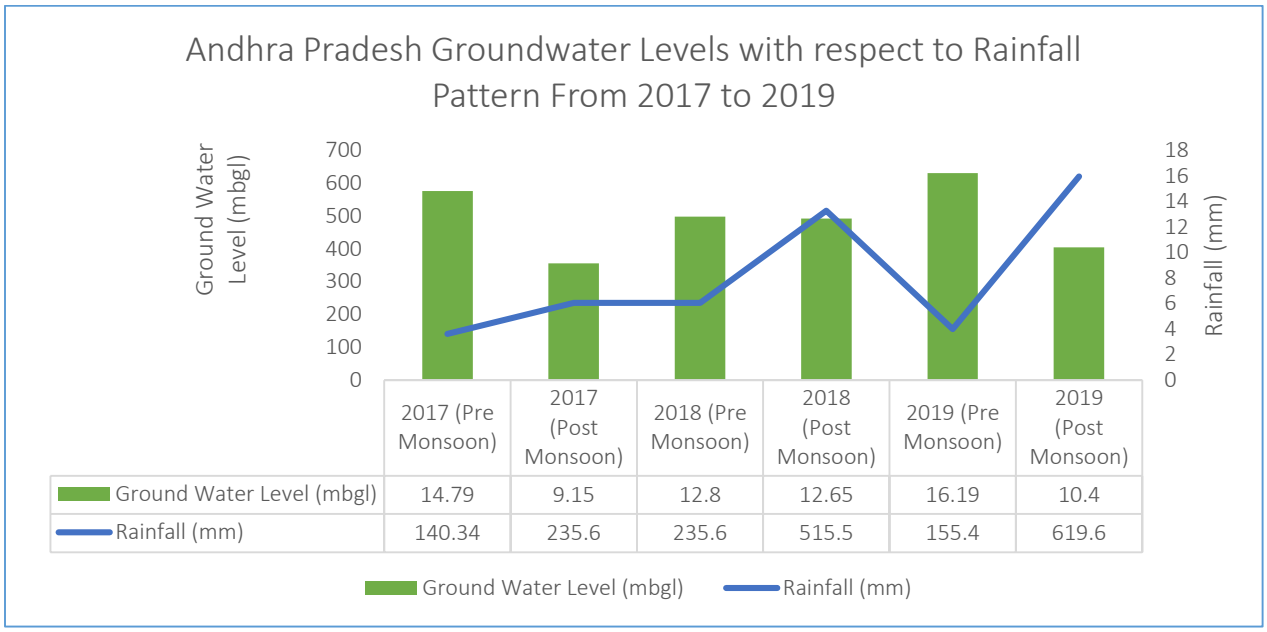
Questionnaire for Gram Panchayat/ NGOS:

1. What apprehensions were there during the inception of the project?
2. Has it affected any areas yield growth patterns?
3. What are the current issues being faced at the ground level in relation to the EEPS?
4. How has the village/ area benefited in its agricultural produce after the installation of EEPS?
5. Why were the farmers reluctant to implement this project?
6. Are farmers being willing to install EEPS now?
7. What support was provided from the NGOS end to create awareness regarding this project?
8. Were there any complaints regarding the project from the farmers end?
9. Any impact noticed in socio-economic condition of farmers covered under the scheme

Questionnaire for pump manufacturers:

1. What is the percentage efficiency guaranteed for energy savings per pump?
2. What issues were faced during the pump manufacturing and installation?
3. Was there any reluctance from the beneficiary's end during the Pump installation?
4. What were the obstacles faced during the integration of the smart panel into the EEPS?
5. Did you measure and record the ground water status at the installation stage of the pump? What was the district wise cumulative baseline consumption?
6. Have you received direct complaints with regards to the performance of the submersible pump?
7. If yes, how did you resolve the same? Was the issue recurring in nature?
8. Have you conducted any third-party audits on the installed pumps for M&V purposes?
9. What is the frequency of maintenance activities? How well pumps are performing currently?
10. How many employees were hired freshly for this project?
11. Any input to improve program for further scaling up of project.

Annexure -3



Annexure – 4