VOL. 4, NO. 2, APRIL 2009 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

ANALYSIS ON ELECTRICAL ENERGY CONSUMPTION OF AGRICULTURAL SECTOR IN INDIAN CONTEXT

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ABSTRACT

This paper attempts to identify inter-linkages between agriculture and Electricity. The growth of agriculture has been possible because of timely and adequate supply of water. As a result, ground water irrigation started assuming greater importance as compared to canal irrigation. Farmers have better control over water availability with ground water irrigation. A study of Electrical Energy requirements for the irrigation purposes based on crop pattern and area irrigated under various heads has been carried out. The energy audit reports of various departments such as Irrigation, Agriculture and Electric Utilities are some time at variance. This paper highlights the need for proper interfacing between these agencies to evolve a credible strategy for optimum utilization of resources like electrical energy and underground water.

Keywords: electrical energy, agricultural sector, irrigation, energy consumption.

1. INTRODUCTION

There is a growing demand for electrical energy for irrigation requirements in India. Electrical Utilities of many states have been facing acute power shortage which led to unrest in the farmers in many states. It is observed in the last few decades, the underground water levels have been falling down drastically and cultivated area has been increasing by cutting the forests. Hence, there is growing demand for electrical energy for irrigation. The generation is not growing proportionately to the growing demand. On the other side, the available energy is also not properly utilized for Agricultural purposes. The farmers have to be educated in the area of energy conservation and proper utilization of available resources in the country. This paper highlights the differences in the energy requirements and actual energy consumption with statistics.

Lack of perennial rivers made ground water tapping a prerequisite in irrigation in south India. This has led to an increase in consumption of electricity by agricultural sector. 73% of Indian population depends directly or indirectly on agriculture. About 50% of Indian populations are farmers. About 20% of the farmers have electric pumps. Hence, only 10% of population directly benefit from agricultural electricity use. In most of the states, agricultural consumption is un-metered. Consumers pay a flat rate tariff which is also highly subsidized. However, a large part of the subsidy is cornered by richer, larger farmers. In Maharastra state, 80% of the farmers depend on rain fed agriculture. Out of the remaining 20% farmers, those with large land-holdings (2% of the farmers) capture 20% of the subsidy.

This situation however leads to a cycle of problems. There is no benefit to small or marginal farmers. Improper targeting of agricultural subsidy has led to improper crop selection and competitive well deepening. This in turn has led to over use of ground water and lowering of the ground water table which has a severe impact on the poor farmers. In some states the situation is extremely dire. In Maharastra the water tables are falling by 2-6 meters each year. In Punjab, 79% of ground water blocks are either overexploited or critical. In Haryana, in 59% of blocks, water tables have dropped from 10-15m to 400-450meters. In Tamilnadu, 46% of blocks are either critical or overexploited. In Rajasthan the level is going down by 1-3m every year. Groundwater levels have fallen to such an extent in this state that mining is required to extract water which cannot be replenished by rain.

The overall impact of all these factors is that as water levels fall, power use increases to pump the same quantity of water out of the ground. The cost of well deepening and replacing pumps by pumps of higher rating is paid by farmers who can afford this cost. Thus the cost increases while the agricultural output does not increase. In effect, the power subsidy increases inequality among farmers.

Some measures are being taken by various State Regulatory Commissions as well as power utilities to target subsidies to improve the situation. For example, in Andhra Pradesh, big farmers do not get free power and farmers in draught prone areas are charged at a lower tariff. In Haryana, the tariff is linked to the depth of the water table in the region. In Karnataka, the tariff depends upon the economic status of the farmer.

Many measures have been introduced to reduce agricultural consumption. Schemes like ‘single phasing’, (providing power supply on single phase so that agriculture pumps do not operate, while the household lights can work), separate feeders for agricultural pumps, metering distribution transformers supplying pump sets are examples. These help to get better understanding of the agricultural consumption and can also enable restricted supply of electricity for pumps. Some states like Andhra Pradesh, Madya Pradesh and Uttar Pradesh have limited the hours of supply (7, 6 and 10 hours/day respectively) to reduce the water and power use.

It has been realized that there is scope for improving efficiency of electricity use by pump sets. The current efficiency levels are 20-30%. It is estimated that of

7-10% is possible by the use of efficient motors, installing capacitors, use of plastic pipes instead of iron and use of frictionless foot valves. In addition to reducing consumption, improving efficiency of the agriculture power use has an additional benefit of improved quality of power supply due to reduced losses and improved voltage levels. Better voltage in turn improves water discharge and reduces motor burnouts. The state of Andhra Pradesh has made implementation of these efficiency improvement measures mandatory to qualify for free power.

Another important issue is that proper measurement of agriculture power consumption is not available and it is often estimated. Since the agricultural consumption remains un-metered, there is a tendency to over-estimate, which helps in power utilities to hide their transmission and distribution losses and pilferage. Many have pointed out that the agriculture consumption is much lower than what is projected. The results of survey in some states show that farmers consume 27% less than the utilities estimate and that transmission and distribution losses are therefore correspondingly higher than the utilities claim. (47% compared with the official 33%). It is possible that the large part of the losses is due to pilferage by residential, commercial and low-voltage industrial consumers.

In addition to all these other concerns, power supply to agriculture is highly un-reliable with frequent power cuts and low voltages. The poor quality of supply leads to transformer and motor burnouts. Very often, farmers have to undertake repair and maintenance work of service connections and transformers. Thus, even though the tariff is low, the farmer pays high price for the power by having to replace motors very often and not having power supply when needed.

The supply to agriculture is limited to a few fixed hours throughout the day. Agriculture receives power mostly during the non-peak hours. Thus, the cost of supply to agriculture is actually low as they are cut-off from the grid when the most expensive power is used by the other sectors like industrial, residential and commercial sectors.

One of the suggestions has been the 'People's Plan Model' of T.L. Shankar [1]. He suggested that the cheaper sources of power (hydro and old thermal) could be reserved for agriculture. He also suggested that the agriculture consumers could be charged only the fuel cost of power generation. The fixed cost could be paid by those who use power during peak hours. He had worked out details of this model for Andhra Pradesh and Karnataka, but no state has implemented so far.

We need to comprehensively handle all the linked issues-improving power supply quality, targeting of subsidy accounting power consumption, rationalizing the crop pattern, improving the irrigation techniques, optimizing ground water use, regulating farmers, ensuring fair price and market for agricultural products and providing timely credit.

In this work, the electrical energy requirements of a certain area belonging to a part of State Andhra Pradesh in India have been calculated based on crop pattern and available water resources. Eastern Power Distribution Corporation Limited (APEPDCL) caters services to five districts of Northern Andhra Pradesh State. Out of which the above analysis is carried out for three districts. The electrical energy requirements have been calculated based on the area of land irrigated and also based on the crop pattern. The energy consumption is estimated by APEPDCL by connecting meters on 20% of the transformers and for the remaining distribution lines taking the average consumption per 1-horsepower of the motor.

AP State Electricity Board is one of the few fast restructuring utilities in India. The estimated energy given by APEPDCL will be pronounced in this paper as actual energy consumed.

2. STUDIES CONDUCTED

District wise crop pattern has been studied in three districts of Northern Andhra Pradesh in India. Critical estimation of optimum requirements of water quantities for cultivation during Rabi season for various crops based on the area of crop and type of crop has been made. Considering different suction heads for various sources of water, optimal estimation of electrical energy requirements in million units has been made. It is compared with actual amount of energy supplied by electrical utility, APEPDCL.

The study was conducted for Vijayanagaram, Visakhapatnam and East Godavari districts of Andhra Pradesh. Data was gathered from the competent authorities of district Collector's offices. [2, 3 and 4] give detailed data. District wise area of crop irrigated under various sources of water in Rabi season has been presented in Table-1. Rabi season has been considered from October to January. Actual energy consumed data is available for 2004-05. Crop pattern is available for calendar years 2003-04 for Visakhapatnam and east Godavari districts.

Table-1. District-wise area of crop irrigated under various sources of water in rabi season (in hectares).

District	Tanks	Tube wells	Other wells	Lift-irrigation
Vijayanagaram 2000-01	4970	5757	10154	294
Visakhapatnam 2003-04	2926	12193	10621	--
East Godavari 2003-04	176	39536	10	55

The electrical energy requirements and actual energy consumed of different years have been compared considering the average growth rate of 2% in the area of crop irrigated. Between energy requirement and energy consumed, no great difference has been observed during Kharif season i.e. rainy season crop as the energy required by pumps during this season is very much less compared to non-rainy season. Hence, study was restricted to months October, November, December and January. District wise and crop wise area irrigated is presented in Table-2. Volumes of water requirements for various crops are given in Table-3. Paddy requires maximum of all the crops amounting to 75 cm multiplied by the area of the land. Chillies, sugarcane and banana stand next amounting to 50cm multiplied by the area of land. Remaining all crops require the volume of water equal to 35cm multiplied by the area of the land irrigated for that particular crop.

Table-2. Area and crop wise irrigation in various districts (in hectares).

Crop/District	Vijayanagaram	Visakhapatnam	East-Godavari
Paddy	2163	88674	106427
Chilly	2409	3920	467
Sugarcane	7228	64952	8587
Banana	2616	2016	1407
Betal	--	430	--
Maize	--	8327	--
Ragi	1544	33687	--
Vegetables	1766	8760	--
Groundnut	4604	10850	194
Seasomom	324	6965	490
Tobacco	1609	1804	1679
Others	1816	--	--

Weighted average of height of water column for various crops considered for calculating the volume of water drawn from different sources. The sources of cultivation requiring electrical energy are Tanks, Tube Wells / Bore wells, other wells and Lift irrigation. Mass of water drawn from tanks, tube wells and lift irrigation has been calculated from the given data.

Heads for various sources of water presented in Table-4. For all the districts, the heads required for drawing water from various sources of water are same as all the three districts are adjacent to each other and have similar geographical nature. Efficiency of motor and pump set together considered being 42% [6, 7]. In Bernoulli's equation, we have ignored friction in delivery and suction lines; velocity gradient of water between inlet and outlet valves is neglected. Pressure difference between suction and delivery lines is ignored for calculation of estimated energy requirements. In terms of utilities terminology, one unit of electrical energy means one Kilo Watt Hour. The estimated energy requirement in Million Units is compared with actual electrical energy supplied by the utility. District wise, month wise energy consumption data given by the utility, APEPDCL in million units is presented in Table-5 [5].

Table-3. Water requirements for various crops for the total season.

Crop	Volume of water required (hectare cm)
Paddy	Area x 75 cm
Sugarcane/ fruits/chilly	Area x 50 cm
Bajra/groundnut/maize/ vegetables/seasomom	Area x 35 cm

Table-4. Heads for various sources of water (in meters).

Sources of irrigation	Head for drawing the water from the source
Tanks	07
Tube well /bore wells	15
Other wells	10
Lift irrigation	5

3. RESULTS AND DISCUSSIONS

Results are presented in Table-6. Considerable difference in the Energy requirement and energy consumed has been observed during Rabi season. The potential for saving is the difference between estimated requirement of energy and actual energy supplied by the utility. The energy saving potential is highest for East Godavari where cultivation of Paddy is maximum among the three districts. The sum of electrical energy requirements of various sources of cultivation estimated to

VOL. 4, NO. 2, APRIL 2009 ISSN 1819-6608
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be equal to 11.03 million units where as reports from Utility shows that 18.08 million units have been consumed from October, 2005 to January, 2006.

The reasons for having large gap between requirement and consumed energy could be the wastage of electrical energy. The foremost reason can be that the power supplied for agricultural needs is during the night hours. Farmers Switch on the pump motor and leave it 'on' for the whole night. Farmers do not bother to switch off the pump motor when the land is filled with sufficient water level. This is the main source of wastage of electrical energy from the grid. The other disadvantage is that the water tables are falling which results in increase in suction head of tube wells and increases the energy requirement further.

Table-5. District-wise, month-wise energy consumption data given by APEPDCL (million units).

Month/District	Vijayanagaram	Visakhapatnam	East -Godavari
October 2005	4.13	4.85	21.92
November 2005	3.83	3.75	17.55
December 2005	4.88	4.81	25.26
January 2006	6.27	4.67	31.11
Total	**19.12**	**18.08**	**95.84**

Table-6. Comparison of calculated energy requirements and actual energy consumed (million units).

Energy/District	Vijayanagaram	Visakhapatnam	East Godavari
Estimated electrical energy requirements	6.53	11.03	27.74
Actual electrical energy supplied by utility	19.12	18.08	95.84
Energy savings potential	12.59	7.05	68.1
Estimated percentage of energy savings	65.85%	38.89%	71.06%

4. CONCLUSIONS

Measures to bridge the gap between electrical energy required and consumed have to be taken on high priority to solve the power crisis in Andhra Pradesh State. Farmers have to be educated on conservation of water and electrical energy and an intelligent system has to be devised which gives the information of water requirement to the farmers and energy requirement to the utility from time to time for optimum utilization of electrical energy. The decision making system should be supplied with the data of crop pattern, rain fall pattern and land pattern for efficient utilization of electrical energy. An automatic control system can be developed to trip the pump motor by sensing the humidity of the land under irrigation.

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