# Note on
# Agriculture DSM in the background of Low Carbon Policies in Electricity sector in Andhra Pradesh

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# Introduction

Adverse climate changes have become all too obvious. Increasing number of people are being exposed to these adverse climate changes. Well being of individuals is being impacted by these climate changes. Because of its impacts climate change has become an important issue in social and economic policies, not to speak of environmental policies. While receding glaciers is being reported from different parts of the globe including Himalayan ranges in India floods have visited even desert areas of Rajasthan. It is needless to mention that droughts have become more severe.

Over the last century annual mean temperature increased by 0.68°C. Extreme weather conditions were experienced in different parts of the country. The number of hot days increased along with frequency of heat waves. These severe weather conditions also led to increase in deaths. While some parts of the country were inundated with flash floods other parts received decreased monsoon rainfall. These areas experienced delayed as well as lower number of rainy days. Some of the serious floods in the recent past include floods in the north eastern states during 2002, 2003, and 2004, in Mumbai during 2005. Droughts also have become frequent and severe playing havoc with rural lives. Crop losses and declining ground water table severely affected food security and health. Agriculture suffered from both flash floods and droughts.

Greenhouse Gas (GHG) emissions is an important contributor to these climate changes. In the year 2008 global average of GHG emissions stood at 4.38 tonnes CO2 equivalent per capita. This needs to be drastically brought down to avert global disaster in the coming days. Though India is one of the lowest GHG emitters with an emission of 1.18 tonnes CO2 equivalent per capita and its contribution to historical stock of GHG emissions was very low it also need to contribute to mitigating climate changes through reducing its GHG emissions.

Government of India (GoI) has taken an important initiative by announcing that it will reduce the emissions' intensity of its GDP by 20 percent over the 2005 levels by the year 2020. The National Action Plan on Climate Change formulated by GoI can be considered as an attempt in this direction. This action plan envisages eight national missions. Out of these missions the one on Enhanced Energy Efficiency has bearing both on electricity and agriculture.

According to the Interim Report of the Expert Group on Low Carbon Strategies for Inclusive Growth in 2007 India's GHG emissions was 1904.73 million tons CO2 equivalent (p.24). Electricity sector was the biggest contributor to these emissions in the country. It accounted for 38% of the GHG emissions. The emissions from electricity generation stood at 719.31 million tons CO2 equivalent.

While on the one hand agriculture is suffering from adverse climate changes on the other it is also contributing to GHG emissions to some extent. Because of the government policies like cheaper electricity to agricultural wells and also because of farmers' attempts to address uncertainty in dry land farming well irrigation with electrified pump-sets increased considerably. With this consumption of power in agriculture increased. Now more than one fifth of the power consumed is accounted for by the agriculture sector. Reduction in consumption of power in agriculture sector will go along the way in reducing GHG emissions.

# Part I

## The need to look at agriculture as it is one of the important electricity consumers

Table: 1 **Well Irrigation in Andhra Pradesh**

| Year | Gross Irrigated Area under wells (Hectares) | Gross Irrigated Area under all sources (Hectares) | % of well irrigation in total gross irrigation |
|---|---|---|---|
| 2003-04 | 2572744 | 4780683 | 53.82 |
| 2004-05 | 2563324 | 4986718 | 51.40 |
| 2005-06 | 2796080 | 5996466 | 46.63 |
| 2006-07 | 2891635 | 6069570 | 47.64 |
| 2007-08 | 3174279 | 6284782 | 50.51 |
| 2008-09 | 3417025 | 6740562 | 50.69 |
| 2009-10 | 3342531 | 5763957 | 58.00 |

Source: Season and Crop Reports, Andhra Pradesh

Well irrigation has emerged as an important source of irrigation in Andhra Pradesh. During the last seven years contribution of wells to irrigation in the state had ranged from 46.63 percent to as high as 58 percent of the total area irrigated under all sources in the state. During the year 2009-10 the latest year for which data were available wells contribution had stood as high as 58 percent. Spread of well irrigation started in 1980s coinciding with the green revolution in Indian agriculture. Contribution of well irrigation to total irrigation increased from 22% in 1984 to 51% in 2003. Most of this well irrigation spread in dry land, drought prone areas, particularly in Rayalaseema and Telangana regions in the state. During the last two decades of $20^{th}$ century well irrigated area increased by four times in districts like Srikakulam, Vizianagaram, Visakhapatnam, Kurnool, Warangal, and Adilabad districts. While fast depleting ground water resources reflected in declining water tables in all parts of the state indicates the risk involved in depending on well irrigation on a sustainable level it is also important to acknowledge the contribution made by well irrigation to food security, rural livelihoods and economic

development in the state. This well irrigation helped to insure the state economy from vagaries of monsoons. Farmers turned to well irrigation to protect themselves from the crisis faced by dry land agriculture. As the ground water levels depleted to alarming levels in several districts in the state well irrigation is no more in a position provide that protection against the crisis engulfing the dry land agriculture. A large number of farmers suicides may be attributed to farmers spending huge amounts on failed bore wells. And it is no wonder that most of the farmers suicides are reported from drought prone districts. Here it is to be noted that unlike under surface irrigation under well irrigation capital contribution comes almost totally from farmers themselves. Hence, here the risk is entirely borne by the farmers.

Electrification of irrigation pump-sets contributed considerably to the spread of well irrigation in the state. In 1970s and 80s the state government encouraged farmers to energise their pump-sets through lower electricity tariffs as a part of its efforts to increase food grain production. This also had become as a solution to face uncertainty and also (indirectly) expand land resources through increased farming intensity in the presence of land scarcity. (Narendranath *et al*, 2005 and Tushar Shah, 2009). The number of agriculture services increased from 4,22,418 in 1980-81 to 18,21,280 in 200-01. During this period connected load of agriculture services increased from 1,614 MW to 6,276 MW. (Power Development in Andhra Pradesh 2006-07, APTRANSCO)

# POWER CONSUMPTION IN AP

Table: 2 **Power Consumption** (In MU)

| **Consumer Categories** | **1980-81** | | **2000-01** | | **Growth rate %** |
|---|---|---|---|---|---|
| **L T Supply** | **(45.04)** | **2050** | **(75.21)** | **20464** | **898** |
| Domestic Supply | (12.00) | 546 | (21.71) | 5908 | 982 |
| Non Domestic | (04.79) | 218 | (04.54) | 1235 | 466 |
| Industrial Supply | (08.46) | 385 | (06.18) | 1681 | 336 |
| Agriculture | (19.55) | 890 | (40.63) | 11055 | 1142 |
| **H T Supply** | **(54.96)** | **2502** | **(24.78)** | **6743** | **170** |
| **Total Consumption** | | **4552** | | **27207** | **497** |

Source: Power Development in Andhra Pradesh – 2006-07, APTRANSCO

The above table shows the change in consumption pattern. During the two decade period agriculture consumption has increased by 1142 percent, highest among all the consumer categories. As a proportion in total power consumption agriculture consumption accounted for 19.55 percent in 1980-81 it increased to 40.63 percent in 2000-01. This consumption trend raises many questions. While one of the questions is related to the correctness of the agriculture consumption data other question is related to efficiency in electricity consumption in agriculture sector.

## ISSUES IN QUANTUM OF POWER CONSUMPTION IN AGRICULTURE

Table: 3 **Power consumption in Agriculture in Andhra Pradesh**

| Year | Total Power Consumption | Power Consumption in Agriculture | % of Agriculture Consumption |
|---|---|---|---|
| 2003-04 | 42342.00 | 12406.04 | 29.30 |
| 2004-05 | 46255.00 | 13392.31 | 28.95 |
| 2005-06 | 47831.27 | 13266.81 | 27.74 |
| 2006-07 | 56775.25 | 15535.33 | 27.36 |
| 2007-08 | 61608.38 | 15789.11 | 25.63 |
| 2008-09 | 66539.31 | 16307.30 | 24.51 |
| 2009-10 | 72493.57 | 17670.22 | 24.37 |
| 2010-11 | 78351.16 | 17723.03 | 22.62 |
| 2011-12 | (106%)87381.00 | (50%)18581.84 | 21.27 |

Source: ARR of Four DISCOMs

As the agriculture services are not metered its power consumption is to be arrived through an estimation process recommended by APERC. But as the filings of the DISCOMs shows that they were not following the method properly and in the end the estimation of power consumption appears to have been arrived through an elimination process. After deducting the power consumed by the consumer categories with meters the remaining unmetered power is divided between agriculture consumption and T&D losses. DISCOMs in order to hide their inefficiencies they show higher agriculture consumption and lower T&D losses.

It has been alleged that because of lower tariffs or almost free power farmers are using electricity indiscriminately. But the facts show that this is not true. The above table itself shows that agriculture consumption in total power consumption declined from 29.3% in 2003-04 to 21.27% in the year 2011-12. During this period while total power consumption in the state increased by 106% power consumption in agriculture sector increased by only 50%. From this one could infer that the pressure on the electrical network is coming from other consumer categories but not from agriculture.

Agriculture consumption is overestimated through taking in to account more number of wells and more number of days of pump-set operation. These are examined below.

Table:4 **Number of wells in Andhra Pradesh**

| Year | No. of Agriculture Services according to | No. of wells according to Season and Crop Reports | Cropping Intensity (% of area irrigated |
|---|---|---|---|

| | DISCOMs | | more than once) |
|---|---|---|---|
| 2003-04 | 2004054 | 1792407 | 37.62 |
| 2004-05 | 2077956 | 1803759 | 34.65 |
| 2005-06 | 2250256 | 1794282 | 40.77 |
| 2006-07 | 2296996 | 1860620 | 39.45 |
| 2007-08 | 2400870 | 1998375 | 38.79 |
| 2008-09 | 2601563 | 2163717 | 47.08 |
| 2009-10 | 2768295 | 2203475 | 46.36 |

Source: ARR of Four DISCOMs and Season and Crop Reports

One of the contentious issues in computing power consumption in agriculture sector is the number of agriculture services in operation. The estimation of power consumption is based on the number of services and their HP. It is contended that the number of services is overestimated as services that were not operation are also being included in this list. A comparison with the number of wells provided in the Season and Crop Reports of Andhra Pradesh will help to throw some light on this. In the year 2003-04 while there were 20,04,054 agriculture services according to the DISCOMs' filings there were 17,92,407 wells according to Season and Crop Report. Similarly, for the year 2009-10 while there were 27,68,295 agriculture services according to the DISCOMs' filings there were 22,03,475 wells according to Season and Crop Report. The difference in number of wells between the two sources is not insignificant.

This number can further be corroborated with the help of minor irrigation census. This census is carried out once in seven years. The latest census is available for the year 2006-07. According to 4$^{th}$ Minor Irrigation Census of 2006-07 there were 22,00,361 wells in the state. Out of them 2,33,987 wells were not in use. That is in the year 2006-07 there were 19,66,374 wells in use or in operation in the state. During the same year while there were 22,96,996 agriculture services according to the DISCOMs' filings there were 18,60,620 wells according to Season and Crop Report. (The number of wells mentioned under both Season and Crop Reports and Minor Irrigation Census also include wells that were not electrified. These wells number about one lakh). On the basis of Minor Irrigation Census also one could conclude that the number of agriculture services taken in to account by DISCOMs is overestimated.

While estimating agriculture consumption often it is assumed that two crops are grown under each well and on the basis of it the number of days of providing irrigation is adopted. Usually number of days of irrigation assumed ranges between 150 days to 200 days. But an examination of Season and Crop Reports show that the percentage of area irrigated more than once ranges between 34.65 (2004-05) and 47.08 (2008-09). In other words second crop is grown in less than 50% of the area under well irrigation. Then assumption of even 150 days of irrigation would amount to overestimation.

After free power to agriculture was implemented power supply duration was reduced to 7 hours from 9 hours from the year 2003-04. In response to this reduction in duration of

power supply by more than 20% there should have been reduction in power consumption in the agriculture sector. Contrary to this power consumption is shown to be increasing.

In sum power consumption in agriculture sector was overestimated. Nevertheless, agriculture continues to be an important electricity consumer in the state and provides scope for electricity conservation and saving. These issues are dealt with in the following section.

# Part II

## DSM measures as an attempt to bring down electricity consumption

Demand side management (DSM) is an attempt to bring down power consumption without affecting the performance or output of the targeted consumers. DSM in agriculture sector offers immense opportunities in reducing power consumption without affecting performance of the agriculture sector. Energy saving potential of agriculture DSM programme in India is estimated to be 30-40%. This besides reducing the subsidy burden of the state government helps in bringing down emissions from power plants following reduced power generation requirement. For example, improved efficiency of pump-sets mean lower electricity consumption which in turn imply lower power generation leading to lower CO2 emissions.

## The present agriculture DSM Policy

The Congress party came to power in May 2004 in the state of Andhra Pradesh after nearly a decade. One of the important promises made in its election manifesto was providing free electricity to agricultural pump-sets. The first file that Mr. Y.S. Rajasekhar Reddy signed immediately after swearing in as the Chief Minister on May 14, 2004 was on providing free electricity to agricultural pump-sets. During the second year of its rule the state government intended to make some amendments to its free power policy in order to preclude indiscriminate use of electricity and avoid consequent financial burden on the state government. Accordingly, the Government of Andhra Pradesh (GoAP) announced a modified policy in relation to power supply to agricultural consumers - "Policy on Supply of Power to Farm Sector" on January 25, 2005.

The modified agricultural power policy distinguishes between different agricultural consumers based on factors such as type of ownership (corporate farmers/IT assesses), access to canal irrigation (wet land/dry land) and size of holdings or number of connections per family. The emphasis of the new power policy is on energy conservation through Demand Side Management (DSM) measures with lower tariffs for those adopting DSM measures. Even those consumers who would be provided power free of

cost have to adopt DSM in a time bound manner failing which they would no longer get the benefit of free power. All new connections would have to adopt DSM measures and meters have to be fixed.

The modified policy is as follows:

a) Farmers in dry land areas having up to three connections in the name of their family will continue to get free power. They will have to undertake DSM measures i.e. install capacitors in working conditions of adequate rating and frictionless foot-valve, wherever required, for their pump-set by March 2006 and adopt the remaining DSM measures i.e. HDPE or RPVC piping and ISI marked pump-sets by March 2008, failing which, they will fall under Tatkal scheme and would not be eligible for free power supply.

b) Farmers in dry land areas who are eligible for free power supply shall not grow paddy in second crop. If they do so, they will fall under Tatkal scheme and they will be charged at the tariff of Rs. 0.20 per unit or equivalent flat rate tariff. They will not be eligible for free power for that crop.

c) Farmers in dry land areas having more than three connections in the name of their family will be charged a tariff of Rs. 0.50 per unit or equivalent flat rate tariff or a tariff of Rs. 0.20 per unit or equivalent flat tariff if they adopt DSM measures.

d) Small and marginal farmers (owning landholding size of wetland up to 2.5 acre) supplied water through major and medium irrigation schemes (wetland areas) will continue to get power free of cost. However, they will have to undertake DSM measures failing which they will fall under Tatkal scheme and would not be eligible for free power supply.

e) Other farmers (other than small and marginal farmers) in wet land areas will be charged a tariff of Rs. 0.50 per unit or equivalent flat tariff. In case they adopt DSM measures, they will be charged a tariff of Rs. 0.20 per unit or equivalent flat-rate tariff measures.

f) The corporate farmers, who include Companies registered under the Companies Act, 1956, Partnership Firms within the meaning of Indian Partnership Act, 1932, Societies registered under the Societies Registration Act, 1860 or under any other applicable legislation and Trusts registered under the Indian Trusts Act, 1882 and any other Bodies Corporate that may be notified from time to time and Income Tax Assessees owning agriculture land will be charged a tariff of Rs. 2.00 per unit as they have alternate source of income and do not depend on agriculture activity for sustenance. However, a 50% incentive shall be permitted if such farmers adopt DSM measures. Metering will be compulsory and no supply will be based on flat-rate tariff.

g) All new connections, both under free power category and Tatkal scheme will be released subject to the condition that DSM measures are adopted and Meters are fixed.

The Andhra Pradesh Electricity Regulatory Commission (APERC) had accepted the DISCOMs' proposals and the new categorisation of agriculture as per the GoAP policy. In the case of agricultural consumers already following DSM measures the tariff is as follows: Dry land farmers with 3 or less number of connections and wet land farmers with land holdings of 2.5 acres or less need not pay any charges. Other farmers have to

pay Rs. 210 per HP per year or 20 paise per unit. Corporate farmers and Income Tax (IT) assesses have to pay one rupee per unit. In the case of agricultural consumers not following DSM measures the tariff is as follows: Dry land farmers with 3 or less number of connections and wet land farmers with land holdings of 2.5 acres or less need not pay any charges. Other farmers have to pay Rs. 525 per HP per year or 50 paise per unit. Corporate farmers and IT assesses have to pay two rupees per unit.

The farmers eligible for free supply under dry land as well as wet lands have to comply with the following DSM measures in the following stages failing which they shall not be eligible for free power supply. Stage – I to be complied by Mach 2006: frictionless foot valve and capacitor of adequate rating for the pump-set. Stage – II to be complied by March 2008: HDPE or RPVC piping suction and delivery and ISI marked mono bloc or submersible pump-set. Free supply shall not be allowed for Paddy crop in second crop. Farmers in the dry land areas shall not be eligible for free supply if they grow paddy in second crop. All new connections shall be given only with DSM measures implemented and with meters (paragraph 713, Tariff Order 2005-06, APERC).

The GoAP justified free power to agriculture as an attempt to reduce the gap in cost of irrigation between well irrigation and canal based irrigation. According to the new policy document "Government spends substantial amounts on irrigation projects and supplies water at nominal rates to the farmers in the canal irrigation system whereas the farmers in upland areas have to incur capital expenditure for drilling wells, purchasing motors and securing electrical connections. Paying recurring tariff will therefore be unaffordable burden on them. Thus, there existed a case for supply of free power to agricultural pump-sets in the upland areas in the State."

The GoAP considered the free power to agriculture as only a symbolic gesture in the form of providing an immediate healing touch in the background of continuing severe drought implying that it could be altered at a future date. It opined that a set of comprehensive measures in the long-term would be needed to address the basic problem. Significant impetus given to lift irrigation schemes in different parts of the state was expected to bring down reliance on ground water usage. The new policy document issued in January 2005 noted that during the initial five month (June-October 2005) coinciding with Khariff season there was proliferation of unauthorized electrical pump-set connections leading to over exploitation of ground water. The unplanned increase in agricultural power consumption had placed enormous strain on the existing grid network. The network had witnessed new peak consumption of 160 MU in a day during Khariff season. This unplanned increase in consumption was said to have led to purchase of costly power and frequent grid disturbances. This unplanned excessive load on the system led to increased distribution transformer (DTR) failure and to voltage drop resulting in burning of motors. All these developments linked to each other caught the attention of the GoAP. The policy document also noted that there were calls from different quarters to re-examine free power to agriculture as such a 'open policy' might not be sustainable and would be neither in the interest of the sector nor would it serve the best interest of the State, particularly the agriculture community. In this background the GoAP was said to have organized seminars at district and state level on this issue and

these workshops were said to have emphasized the need for a "well-defined" subsidy policy so that the benefits of government subsidy reach the "needy" farmers and the need to effectively administer the subsidy. These seminars also emphasized the need for DSM measures to induce efficiency and accountability in utilization of power and water. It was in this background that the GoAP decided to implement a modified policy in the name of providing the benefit of free power to most needy farmers in an equitable and effective manner, and encouraging more efficient use of power though adoption of DSM measures. The DSM measures contemplated include installing capacitors, frictionless foot valves, HDPE or RPVC piping and ISI marked pump-sets.

According to the document of modified "Policy on Supply of Power to Farm Sector" DSM measures were introduced as an attempt to introduce 'well-defined' subsidy policy and its effective implementation so that the burden on DISCOMs and the state government would come down. "A Discussion Paper on DSM Measures in Agriculture" issued in August 2005 drew attention to reduction in carbon dioxide emissions resulting from implementation of these DSM measures in agriculture. According to this Discussion Paper key benefits which are likely to accrue by way of DSM are: The peak requirement of electricity as well as total energy requirement will decrease thus postponing capacity addition. There will be considerable savings in T&D losses as the end consumption will decrease. The power sector in India contributes nearly 40% of carbon dioxide emissions. The reduced capacity addition will lead to reduced emissions. There is a possibility of significant earning by way of trading in carbon credits. Savings in electricity will lead to reduced emissions and hence accrual of carbon credits. The Discussion Paper also mentioned that decrease in consumption will lead to reduction in subsidy by the government and cross subsidy burden on subsidizing consumers. The Discussion Paper also calculated that a total financial benefit of Rs. 618 crore (Rs. 522 crore from reduced subsidy burden and Rs. 96 crore from trading in carbon credits) would accrue from implementation of DSM measures in agriculture in the state.

Components of the DSM Policy:

1. Installation of capacitors.
2. Frictionless foot valves
3. HDPE/RPVC piping
4. ISI standard motors/pump-sets.
5. New connections shall be issued only if all the above three measures are adopted.
6. Paddy shall not be grown as second crop.

# Past interventions in Agriculture DSM in AP

Table:5 **List of DSM Programmes in AP**

| **Year** | **Programme** |
|---|---|
| 1985-86 | Andhra Pradesh (APSEB/REC) pump set rectification |
| 1987-90 | Andhra Pradesh - Chittoor district. (DFID) |
| 1993-96 | Andhra Pradesh - Warangal district. (JBIC) |
| 1996-99 | Andhra Pradesh (Ministry of Power – Government of India) |

| | |
|---|---|
| 1998 – 2000 | Andhra Pradesh - Nalgonda district. (APTRANSCO/DFID) |
| 1998 – 2000 | Andhra Pradesh - Karimnagar and Chittoor districts (part of WB-Norway AIJ project), |
| 2002 | USAID initiated WENEXA in AP |
| 2005 | USAID initiated WENEXA in AP |

Before the GoAP came out with the modified policy on power supply to agriculture sector in January 2005 there were several attempts spread over two decades at DSM measures in agriculture sector. In most of these interventions the GoAP or erstwhile Andhra Pradesh State Electricity Board (APSEB) or later APTRANSCO/DISCOMs were active partners. A look at the policy document shows that the experiences form these interventions were not taken into account while formulating the new policy. What is more, information on most of these interventions is not readily available.

In 1985-86 APSEB replaced GI suction and delivery pipes with RPVC pipes and replaced the existing foot-valves with improved ones of 2,500 pump-sets in Chittoor district. A sample study of 505 of these pump-sets showed that replacements led to energy saving of 26.17%. Water delivery increased from 9.70 liters per second (LPS) to 13.58 LPS. Increase in water delivery led to reduced electricity usage time. (IEI. p.6-7). Though the report mentions that farmers were impressed by the improved water flow there was no evidence that farmers had gone in to replacement of the pump-set parts on their own.

A technology demonstration project with an objective of covering 7,200 pump-sets was undertaken in Warangal district with the support from the Japanese OECF (now JBIC) during 1993-96. The response from consumers to this conversion program was mixed and only about 2,010 pump-sets were replaced by efficient single-phase models. (World Bank, p.36)

A DFID funded programme during 1998-2000 to improve working of power sector in AP included replacement of the 3 phase low voltage distribution system with single phase high voltage distribution system (HVDS). This activity was taken up during 1998-2000 in Nalgonda district. The programme aimed at replacement of more than 3,200 three phase pump-sets with single phase motor pump-sets under HVDS distribution system spread over 16 villages. When the scheme was closed prematurely in September 2000, 1,641 pump-sets spread over 11 villages were replaced. A study of this intervention brought out problems in implementing this.

At the time of initiation of this programme the pump-sets did not conform to standard specifications and they were not properly maintained. Capacitors were not installed for power factor correction. There difficulties in recording the HP capacity of the then existing pump-sets. The pump-sets were also not operated efficiently. In the face of uncertain hours of power supply automatic starters were used. The power voltage hovered in the range of 200 – 350V, instead of 415V ±10V. All these led to high motor

burnout rates. According to this study the average burnout rate stood at about 2.8 per year.

During the programme implementation cooperation from farmers was not forthcoming. Their expectation from the programme was different from its design. Some farmers did not agree for replacement of their existing pump-sets with single – phase pump sets as per their contract-load. They were operating higher-rated pump sets. Farmers with unauthorized connections also posed a problem in the implementation of the programme. The programme allowed regularization of the unauthorized connections. Still the response from these farmers was less than encouraging. Some farmers did not allow the removal of the 3-phase transformers expecting that the three phase transformers would be reinstated later. Farmers were apprehensive about service conditions once the programme/guarantee period was over. As the motor burnouts increased either due to low voltage power supply or due to faulty operation of the motors by the farmers motor manufacturers/contractors demanded reimbursement though initially they replaced burnt-out motors without reimbursement. Some local electricians who depended for their income on rewinding of burnt-out motors created problems in the implementation of the programme as it adversely affected their livelihood. The study noted efficiency improvement with the introduction of the single-phase pump-sets. The efficiency improved from 27% to 36%. This would result in reduced running hours and energy use. Single phase model adopted under this programme posed problems. (World Bank, p.36, IEI, pp.8-10)

Learning from this experience, the AP Integrated Agricultural Energy Efficiency Pilot project taken up under Activities Implemented Jointly (AIJ) Program of the World Bank and funded by the Government of Norway adopted HVDS in three phase configuration. This pilot was expected to cover about 5,800 pump-sets connected to two 33/11 kV substations in Chittoor and Karimnagar districts. As a part of this pilot project an outreach program explaining the benefits of the new distribution system and a voluntary efficient pump-set scheme was taken up to create awareness among farmers. This pilot project aimed at improving end use efficiency from about 25% to about 50%. This pilot was expected to be completed by December 2002. (World Bank, p.36)

Agriculture DSM measures were also part of USAID's Water and Energy Nexus (WENEXA) activity initiated on a pilot basis in Maheshwaram watershed in Ranga Reddy district of Andhra Pradesh, falling in the service area of Andhra Pradesh Central Power Distribution Company Limited (APCPDCL). This activity was initiated in 2002. WENEXA addresses both water efficiency and electricity efficiency issues. 1,200 agricultural power connections spread over 6 villages in Maheshwaram mandal were expected to be covered under this activity. Interventions taken up under this programme included improving quality of power supply to farmers while simultaneously promoting demand side management at farm level. Energy interventions included improving distribution infrastructure through system upgrades, metering on a pilot basis and demand side management interventions included potential crop shifts based on water balance studies, crop water budgeting, educating farmers on the changes in groundwater and

methods to plan their crops depending on the availability of the groundwater, and introduced concepts of micro-irrigation.

The second phase of USAID's Water and Energy Nexus Project (WENEXA II) was announced by GoAP through G.O.MS.NO.65, dated: 14-3-2005. The G.O. mentions that the first phase was a success, and USAID had decided to consolidate the learning from Andhra Pradesh on policy issues through WENEXA II. Objectives of this project include integration of energy management into the Andhra Pradesh watershed development and rural livelihoods programs, improved ground water management to address the energy and water nexus, improved farming systems that allow for rational crop shifts and application of innovative irrigation technologies that reduce water and energy consumption and improved on-farm demand side energy management. Some of the activities contemplated under this project include Maheshwaram ex-post lessons learned on WENEXA I implementation (system upgrade; metering; crop budget analysis; water balance) impacts on water and energy use and efficiency, integration of energy management into the AP Rural Livelihoods Program, analysis of implementation of Andhra Pradesh Water, Land and Trees Act (APWALTA); implementation barriers; groundwater ownership, analysis of current laws, policies and regulations governing Energy Demand Side management and tariff structures, retrospective data collection and analysis of lessons learned in Maheshwaram Watershed impacts on water and energy use and efficiency, Introduction of pump technologies including capacity building (such as training of motor rewinders), and private-public partnerships.

# Implementation of DSM measures

Table:6 **Details of Agricultural Services**

| Year | No. of Agricultural Services | | |
|---|---|---|---|
| | With DSM | Non-DSM | Total |
| 2003-04 | | | 2004054 |
| 2004-05 | | | 2077956 |
| 2005-06 | 303032(13.47) | 1947224 | 2250256 |
| 2006-07 | 2224106(96.83) | 72890 | 2296996 |
| 2007-08 | 2326434(96.90) | 74436 | 2400870 |
| 2008-09 | 2529204(97.22) | 72359 | 2601563 |
| 2009-10 | 2745571(99.18) | 22724 | 2768295 |
| 2010-11 | 2885437(99.19) | 23532 | 2908969 |
| 2011-12 | 3035165(99.22) | 23866 | 3059031 |

Source: ARRs of DISCOMs

Table:7 **Power Consumption in Andhra Pradesh (MU)**

| Year | Agriculture Consumption | Total Power Consumption | Agriculture Consumption as a % of Total |
|---|---|---|---|

| | | | | | Power Consumption |
|---|---|---|---|---|---|
| | With DSM | Non-DSM | Total | | |
| 2003-04 | | | 12406.04 | 42342.00 | 29.30 |
| 2004-05 | | | 13392.31 | 46255.00 | 28.95 |
| 2005-06 | | | 13266.81 | 47831.27 | 27.74 |
| 2006-07 | 15427.72 (99.31) | 107.61 | 15535.33 | 56775.25 | 27.36 |
| 2007-08 | 15682.95 (99.32) | 106.16 | 15789.11 | 61608.38 | 25.63 |
| 2008-09 | 16113.82 (98.81) | 193.48 | 16307.30 | 66539.31 | 24.51 |
| 2009-10 | 17569.09 (99.43) | 101.13 | 17670.22 | 72493.57 | 24.37 |
| 2010-11 | 17605.42 (99.34) | 117.61 | 17723.03 | 78351.16 | 22.62 |
| 2011-12 | 18460.48 (99.35) | 121.36 | 18581.84 | 87381.00 | 21.27 |
| | | | | | |

Source: ARRs of DISCOMs for various years
Figures in parenthesis are percentage of power consumption by pump-sets with DSM out of total agricultural consumption

Filings of DISCOMs with APERC show that 99 percent of the agriculture services are following DSM measures. But these figures do not speak truth. A sample study showed that not even 10% of the agricultural services are following DSM measures (Kimmich, p.9).

Reporting of the DISCOMs on implementation of DSM measures is not reliable. In the ARRs Southern Power Distribution Company Limited (SPDCL) was showing 100% implementation of DSM. In the case of Eastern Power Distribution Company Limited (EPDCL) the figures changed suddenly from first control period under MYT system (2006-07 to 2008-09) to the second control period (2009-10 to 2013-14). During the year 2006-07 the number of pump-sets without DSM were shown as 61,477. This number increased to 62,898 in 2007-08 and later declined to 56,366 in 2008-09. For the three years 2009-10, 2010-11 and 2011-12 the same number '7107' was shown as the number of pump-sets without DSM measures. The fact is that there is no ground level verification of the progress of implementation of the measures.

Proper implementation of DSM measures should have led to considerable energy savings. EPDCL in its ARR for the year 2006-07 maintained, "With full DSM, the specific consumption of the newly released pump-sets from 2005-06 onwards are expected to come down by 20% on an average". (p.25) Similarly, NPDCL in its ARR for the year 2006-07 noted, "In 2006-07 the savings in consumption by the existing pumps is expected to be about 6% on account of installation of capacitors as the licensee is actively pursuing the same through various measures including discussion with suppliers to stock the capacitors at section offices and communicating at various local levels."(p.28) The information provided by the DISCOMs in their ARRs show that there was no reduction in energy consumption and over the period growth in energy consumption kept pace with the growth the number of pump-sets, even in the background of reduction of hours of supply of electricity from nine hours to seven hours.

Table:8 **Annual Growth Rates (%)**

| Year | Agricultural Services | Agricultural Consumption |
|---|---|---|
| 2003-04 | | |
| 2004-05 | 3.69 | 7.95 |
| 2005-06 | 8.29 | - 0.94 |
| 2006-07 | 2.08 | 17.10 |
| 2007-08 | 4.52 | 1.63 |
| 2008-09 | 8.36 | 3.28 |
| 2009-10 | 6.41 | 8.36 |
| 2010-11 | 5.08 | 0.30 |
| 2011-12 | 5.16 | 4.85 |
| 2003-04 to 2011-12 | 52.64 | 49.78 |

Source: ARRs of DISCOMs for various years

The consultant appointed to examine the issue of pump-set replacement - KPMG in its Note submitted to the state government of AP in September 2006 noted that the capacitor installation drive had been successful and focus was to be on other DSM measures related to installation of energy efficient ISI pumps and efficient piping. Though at several places DISCOMs supplied capacitors to the farmers they were unwilling to install them with the apprehension that installation of these capacitors would lead to burning of motors. In fact there were cases where motors were burnt after installation of capacitors. This had taken place due to faulty installation of the capacitors. The staff at the ground level – line men, were not trained in proper installation of these capacitors and also no attempt was made to address the apprehensions of farmers in this regard. In some other cases even when farmers purchased capacitors DISCOMs did not install them citing shortage of staff. (Rama Mohan and Sreekumar, p.13)

According to the Policy Document capacitors need to be installed on all agricultural pump-sets by March 2006. Later this date was extended to May 31, 2006. (The Hindu, May 3, 2006) Later they seem to have forgotten about the whole programme. And APERC religiously repeats the same directions in its annual Tariff Orders. But no one seems to be paying attention to it.

According to a report prepared by KPMG consultants in September 2006 on replacement of pump-sets in AP more than 50 per cent of the pump-sets were not ISI standard pump-sets but were locally manufactured or assembled pump-sets. In 1993 ISI standard submersible pump-sets accounted for 63 percent of the pump-sets in the state. This had declined to 14% in the year 2005. According to this estimate submersible pump-sets accounted for 70% of the pump-sets and the remaining were mono bloc pumps. While in the case of mono bloc pumps farmers mostly purchased ISI standard pumps as the price differential between standard and assembled was not significant in the case of submersible 86% of them are assembled, not compliant with ISI standards. The presence

of higher proportion of sub standard pump-sets indicates the potential for savings through DSM measures. This report also suggested a pilot programme in all the four DISCOMs to examine the performance of the DSM measures. The report also identified the feeders under the four DISCOMs for pilot study.

Initially press reports indicated that state government would meet 80% of the expenditure in replacing the pump-sets and farmers need to meet the remaining 20% expenditure. Financial burden on the state government was estimated to be Rs. 15,000 crore. The decision to bear 80% of the cost was taken in view of the resistance from farmers due to high investment involved in replacing the motor. ( Business Standard, August 12, 2006)

Given the huge investment involved in replacement of pump-sets the GoAP planned to take up a pilot. For this it chose the Central Power Research Institute (CPRI) as a consultant to implement the pilot. The pilot involved installation of 4,000 pump-sets spread over four districts, with one district chosen from each DISCOM. But by middle of 2007 CPRI withdrew from the pilot saying that it did not have adequate staff to install so many pumps and also take regular meter readings to examine the efficacy of the programme. Later the size of the pilot was reduced to 600 pump-sets with a cost of about Rs. 1.10 crore. But even this was not carried out by the end of the financial year 2008 as the finance department did not give green signal to APTRANSCO's proposal. According to the DSM policy adopted by the GoAP the sub standard pumps should have been replaced by March 2008.

The installation of frictionless foot valves and HDPE/RPVC piping did not get attention at all.

According to the new policy as well as the Tariff Orders issued by APERC every year all new connections should be given only with DSM measures implemented and with meters. But even this is not being implemented.

In the case of not allowing paddy as second/Rabi crop there was opposition from the farmers, particularly from Prakasam, Nellore and Chittoor districts. These districts receive monsoon rains late compared to other districts, during North-East monsoons (Paragraph 91, APERC Tariff Order 2006-07). Because of this they sow/transplant paddy late almost falling in to Rabi season. Based on this farmers from these areas were demanding to be exempted from this condition. In the course of time like all other DSM measures no attention was paid to this and farmers continued to raise paddy during second season also.

## Issues in implementing DSM measures:

### Lack of farmers' participation:

One of the reasons for the failure of implementation of DSM measures was lack of proper communication with farmers and their involvement in the implementation of these

measures. In fact APERC in its Order while approving DSM measures underlined the importance of making farmers as party in its implementation. Regarding the DSM measures to be followed by agricultural consumers the Commission observed, "The DSM measures, especially the capacitor compensation for the inductive load of the agriculture sector has been the biggest techno operational problem encountered in the power sector especially in Andhra Pradesh. Past experience appears to indicate that the initiatives taken earlier for providing the capacitors departmentally through APSEB did not achieve the results as the consumers have not been made a party to the scheme and hence did not involve themselves in proper upkeep of the DSM equipment. Similarly any other scheme to provide balance DSM measures like ISI mark pump-sets, frictionless foot-valves etc., that does not involve consumer participation is not likely to succeed especially in the scenario of free power or flat rate supply. The Commission would like to examine this proposal in greater detail through the assistance of other agencies and would advise the Govt. suitably in due course of time" (paragraph 261, Tariff Order 2005-06, APERC). Even after this stated realization of importance of involving farmers in implementation of the DSM measures there was no proactive involvement of farmers in implementation of these DSM measures.

**Absence of technical staff at the ground level:**

One of the reasons for lack of farmers' participation was that there was no effective contact with famers at the ground level. Large number of ground level technical posts called line men are vacant making effective contact with the farmers difficult.

The absence of large number of line men was an independent reason in itself for the failure in implementation of the DSM programme. These technical personnel are needed for installation of capacitors and to assist farmers in implementation of other DSM measures. More than 5,000 ground level technical posts (different grades of linemen) are lying vacant for many years. In rural areas, that encompass agricultural consumers/pump-sets more than 50% of these posts are vacant adversely affecting the quality of supply. Without the presence of these technical personnel it is difficult to implement as well as monitor the implementation of the agriculture DSM policy. Even when farmers procured capacitors on their own they were not installed due to lack of staff. Besides this, Serving linemen are not properly trained in implementation of DSM measures. Because of faulty installation of capacitors electric motors were burnt and this scared the farmers from installation of capacitors.

Filling up of the vacant technical posts in the villages will not be a costly affair. The filling of these vacant posts will cost about Rs. 80 crore. In annual revenue requirement of more than Rs.24,000 crore this is a very small amount. More over spending on vacant posts will not go waste. It will contribute to not only to increased quality of power but also in increased revenues through reduced T&D losses. These returns will outweigh the expenditure towards salaries if all these posts are filled. Instead of this DISCOMs have resorted to technical solutions. They have spent huge amounts on High Voltage Distribution System (HVDS). This is dealt with in another section.

**Distrust between farmers and DISCOMs:**

| Issue | Major Actor | Major Beneficiary |
|---|---|---|
| **Distribution efficiency** | DISCOM | Farmer |
| **Pumping efficiency** | Farmer | DISCOM |

Quality of power supplied to the agriculture services as well as agriculture DSM involves distribution efficiency as well as pumping efficiency. Distribution efficiency includes augmenting DTR capacity and their proper upkeep and maintenance of other rural distribution network in good health. This needs to be done by the DISCOMs. The result of this benefits the farmers while expenditure is to be incurred by the DISCOMs. In the case of pumping efficiency involves using standards motors, installation of capacitors, using frictionless foot valves and HDPE or PVC piping. These needed to be taken up by the farmers. Though this also leads to quality improvement financial benefit in terms of lower power purchase burden will be reaped by DISCOMs. In the implementation of DSM measures, particularly the replacement of pump-sets the question that often crops up is who has to bear the expenditure of replacement of pump-sets, farmers or DISCOMs? It was contended that as the benefit from implementation of DSM through low power purchase expenditure goes to DISCOMs, DISCOMs need to bear the expenditure towards replacement of pump-sets. This leads to a deadlock. As summarized in the above table while costs of distribution efficiency are incurred by DISCOMs benefits reach farmers and while costs of pumping efficiency are incurred by farmers benefits are reaped by DISCOMs. Because of this neither of the agencies is coming forward to do the needful. To this one need to add the distrust that had developed between the two over the period. It is very crucial to break this deadlock.

**DISCOMs' stress on technical solutions:**

For standard (BEE/ISI) pump-sets to operate minimum voltage of power is needed. Under low voltage conditions standard motors do not work. Because of this farmers go in for locally manufactured, sub standard motors that operate under low/fluctuating voltage conditions. The solution then is to improve voltage conditions. The issue then is how to improve voltage of power being supplied to agriculture. One of the reasons for low voltage of power supplied to agriculture pump-sets is overloading of distribution transformers (DTR) serving these pump-sets. Sometimes these DTRs are overloaded to the extent of more than 30%. This could be addressed by installation of additional DTRs. The DISCOMs in the state had taken up replacement of the existing DTRs with HVDS transformers. Between 2005 and 2010 nearly Rs. 5,000 crore were spent on replacing some of the existing DTRs with HVDS transformers. But there was no transparency in implementation of this programme. APERC was requested several times to facilitate transparent review of this programme. But there was no response. Regarding HVDS in its report on Loss Reduction Strategies Forum of Regulators noted, "HVDS was expensive and required larger safety clearance. It was recommended that this system would be more appropriate for areas where LT to HT ratio was poor, rural areas and areas having low connection density."(p.42) Without reviewing experiences from the implementation of

the HVDS programme during 2005-2010 DISCOMs in the state launched another similar intervention involving an expenditure of Rs. 1,130 crore with part financial support from JBIC in 2011.

## A Civil Society Intervention to Improve Efficiency

A civil society intervention in improving energy efficiency in well irrigation after the GoAP's announcement of DSM policy brings out some important issues. Centre for World Solidarity (CWS) and Prayas Energy Group took up a joint study in 2007 and 2008 to explore possibilities of local energy and groundwater management with the involvement of farmers to make constructive contribution to improve the field situation in electricity supply and ground water management. The objectives of the study included gaining insights in to electricity use and water management, and exploring possible areas of interventions in future. For this study they selected two villages located in two districts and involved two local NGOs familiar with these villages as well as interested in electricity and water issues. The initial work included series of discussions with famers from these villages and examination of prevailing technical conditions. The distribution transformers (DTR) in these two villages were over-loaded by 25 to 40%. Un-authorised connections accounted for 30% of the existing pump connections leading to over load of DTRs. Voltage levels were very low – 250 V as against 415 V. This was particularly the case with pump sets located at the tail end of power lines. Hydraulic efficiency was 33% in the case of open wells and 39-49% in the case of bore wells. Burning of motors was frequent. Farmers removed all the capacitors supplied by the Government within a few days of installation thinking that they were not allowing pump-sets to function smoothly under low voltage conditions. A series of meetings were held with farmers and they were motivated to come together. In this exercise DISCOM officials were also involved. In the course of this exercise farmers agreed to install capacitors on all pump-sets. After installation of capacitors it was observed that voltages improved. Current to the pump-sets dropped by 10-15% resulting in reduction of distribution losses by 20-25%. Power factor also improved. Water discharge improved in the case of tail end farmers.

But the results were not that encouraging in regularizing the unauthorized connections. DISCOM insisted paying of fee for regularization of unauthorized connections. They did not agree for any concessions even when the case was taken to the highest officials. Later, CWS came forward to meet 50% of the fee and farmers promptly paid the remaining amount. DISCOM did not issue regularization letters to the farmers. In the meantime local DISCOM official was transferred and the understanding between NGO partners, farmers and DISCOM staff suffered and DTR capacity was not augmented as was promised following payment of regularization fee by the farmers.

The relationship between farmers and DISCOM staff borders on mutual suspicion and lack of trust. During the field level interventions involvement of DISCOM staff helped to bridge the trust to some extent. Thinking through together through joint planning exercise with local partners and farmers instead of top down, expert driven approach helped to understand the problems and formulate solutions.

This intervention showed that though the over-all situation was dismal, there were grassroots opportunities to improve the power supply to agriculture pump-sets with positive and collective approach by DISCOMs and farmers. Positive approach from DISCOMs would help to break the walls of mistrust between DISCOM staff and farmers. DTR can be taken as a primary unit for such intervention. Simple interventions can be taken up within the existing policy framework. DSM measures integrated with efficient water management practices would reduce electricity use in agriculture Models to operationalise energy efficiency need to be evolved within the existing free power policy framework instead of a radical shift to metering all pump-sets, rising tariff and converting all rural distribution to HVDS with large investment. A well designed scheme from DISCOMs with a promise to augment DTR capacity when farmers under a DTR come together and regularise all unauthorized connections was essential to create a favourable environment.

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