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PERFORMANCE ANALYSIS OF THE SOLAR PV UNITS USED TO ASSIST GOVERNANCE IN KARNATAKA, INDIA

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ABSTRACT

The power sector in India is growing at a faster rate in the recent decades. Even with the growth of about 5.6%, an urban population of about 6% and about 33% of the rural population has no access to electricity. The remaining populace is troubled by intermittent and/or unreliable electricity supply. Because of the increasing power shortages the economy is endangered and the governance has become difficult. The governments both at centre and state are facing problems in providing the necessary assistance to the people. Recently the Karnataka state has established centers called 'Nemmadi Kendra' all over the state (approximately 800) to provide an information technology (IT) enabled services from government to consumer at their doorstep. Majority of these centers are situated in rural areas, where the power situation is very depressing. Hence the success of this scheme was fully dependent on the availability of reliable power. Hence, government has come up with a solution to provide power using solar photo-voltaic (PV) power. This paper studies the relevance and performance of these PV systems in the governance.

KEYWORDS: Development, Electricity, Governance, Service, Solar Energy

1. INTRODUCTION

India being a developing country needs energy for its growth. Among the energy sources electricity is a major input for the overall development. In view of this a major thrust has been given for the growth of power sector, just after the independence in 1947. Since then, the Indian power sector has achieved an extraordinary growth from a few number of scattered small capacity power generating stations supplying electricity to small areas to strong regional grids diversified across the length and breadth of the country. With this growth the electricity being supplied to even remote places in almost all the States. Though this expansion was phenomenal, but the country's escalating demand has been constantly outstripping the power supply situation. Now, the current peak shortages are in the range of 12.3% and the energy shortage being 7.7% [1].

The power shortages in most part of the network are forcing the state utilities resort to scheduled and un-scheduled outages regularly. Therefore the ensuing direct and indirect economic impact is enormous, which occurs because of outages resulting from the capacity shortages. Some of the substantial impacts range from millions of dollars of losses in the industrial sector to over sizing of pumping systems resulting in falling groundwater levels at a disturbing rate in the agricultural sector.

The power situation is not much different in Karnataka state, where power outages are regular phenomena. The condition in rural areas is more serious, where the power outages of 18-20 hours a day are common. In such situations

the availability of the government services for the rural population suffers heavily. Most of the governments in India, both at central and state have started implementing the e-governance in all the sectors. The most affected section of the government is the IT enabled service. This mainly involves provision of documents related to land, property and others. It also acts as a link between the government and people, which brings all the governments' schemes to people. The state governments announce various schemes of social development for the people. They need to reach the people and to achieve this governments designate some centers in villages. In Karnataka these centers are referred to as 'Nemmadi' (translated as 'peace of mind' in the language spoken by people of Karnataka) centers. It was the government to citizens e-governance project which was basically developed to provide information, have interactions, transactions etc. between them. Through this a variety of services (more than 38) were offered to rural citizens, which are called as rural digital services.

It was planned to deliver these services through 800 centers situated at hoblis (group of villages) throughout the state. The services offered mainly consist of issuance of certificates/documents in as many as 40 categories. It is the result of people centric program of the government to reach out at the citizens of the state [3]. These services were very essential for the people of rural area for various activities. The success of this project hinged on the availability of quality power supply at all these Nemmadi centers throughout Karnataka. In the initial period of the implementation of the Nemmadi Project, as there was moderate to heavy power outages in all the hobli localities, there was chance of failure of the project itself. Hence Govt. of Karnataka decided to provide solar PV power supply/back up through units called solar power packs to all these centers to make them self reliant with respect to electricity. The government in collaboration with the state nodal agency for the implementation of renewable energy sources called the Karnataka Renewable Energy Development Limited (KREDL) developed a scheme to provide uninterrupted power supply through these units to all the Nemmadi centers.

In this paper the relevance of the independent power supply to Nemmadi centers and their performance is studied. The paper is arranged in the following manner. Introduction is taken up in section 1, in section 2 the details of Karnataka governance, power situation are discussed. Section 3 analyses the performance of the solar PV power units and in section 4 concludes the paper.

2. KARNATAKA: GOVERNANCE AND ELECTRIC POWER SYSTEM

The state of Karnataka is situated in the southern part of India. It falls in the region of 11°35' North and 18°30' North latitudes and 74°5' East and 78°35' East longitudes, and is positioned on a table l and where the Western and Eastern mountain ranges called Ghats, converge into the Nilgiri hill complex. It has an extension of about 750km from North to South and about 400km from East to West. The figure 1 shows the map of India and the map of Karnataka. Its area is about 74,122 sq miles (191,791 km²), which is nearly 5.83% of the total geographical area of India. Among the states of India it is the eighth largest by area, ninth largest by population and consists of 30 districts. Each district is governed by a district commissioner or district magistrate. The districts are further divided into sub-divisions, which are governed by sub-divisional magistrates; sub-divisions comprise taluks containing panchayats (village councils) and town municipalities. According to the 2011 census of India, the total population of Karnataka is 61,130,704, of which 31,109,415 (50.89%) are male and 30,021,289 (49.11%) are female. This represents a 15.7% increase over the population in 2001. The population density is 320 per km² and 33.98% of the people live in urban areas. The State is administered through four Revenue divisions, 52 sub-divisions, 29 districts, 176 taluks and 747 hoblis/Revenue Circles [2].

The structure of governance in India, from capital to villages is from the Principal Secretary of the Revenue Department at the top level and the village accountants at the lowest level. Traditionally, the village accountants used to maintain land records for a group of villages in India. There are officials operating at the hobli (large group of villages), taluk (sub-division of a district), district, division and state levels between the principal secretary and the village accountants. As per the records, in Karnataka, there are 9000 village accountants, each serving three or four villages, for maintaining land records and other records related to the villagers. These records maintained by the village accountants are not subjected to public scrutiny. Villagers had to seek out a village accountant to get a copy of any certificate based on their records.

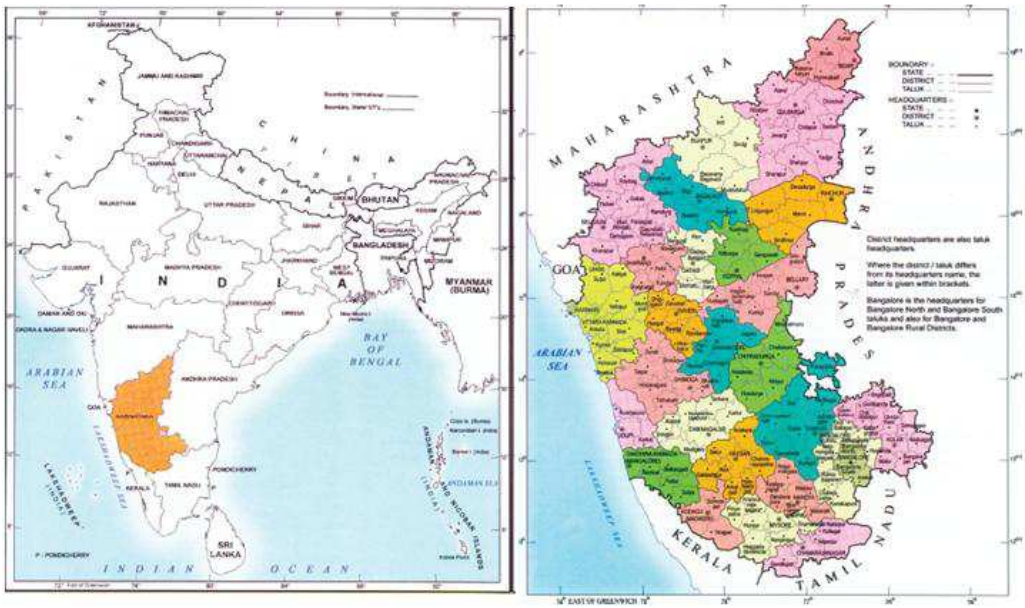

Figure 1: The Maps of India and State of Karnataka [2]

The certificate (based on its type) was a document required for many common tasks, such as admission to schools or colleges, application for government jobs, obtaining bank loans, and applying for benefits under various government schemes such as subsidy for seeds. The villagers could access their personal records maintained by the village accountant only through these certificates. The government system did not provide for any other means of access to and verification of citizen data [3].

In obtaining the certificates by the villagers the role of the village accountant was very crucial. This caused difficulties in majority of the cases of obtaining certificates, because of many reasons which ranged from personal to official. The government after much thought came out with this project, which was to provide all the services provided by the village accountants to the villagers.

The operation of the Nemmadi centers is as following: The centers consisted of a desktop computer system, peripherals and an operator. These are connected with taluk back offices, which process the citizen's request. All these in turn are connected to the central data base centre called the State Data Center (SDC) situated in Bengaluru, the state capital. The exchange of data between the back office and Nemmadi center takes place through the SDC for reasons of security. When a citizen approaches the centre with a request for a certificate, the operator makes an entry of the same into the system, in the required format. If suppose the certificate had been issued previously then operator searches in the

SDC and recovers the existing valid document from the SDC database. Then operator issues a print of the requested document to the applicant. Whereas for a new request, the operator scans the application of the citizen along with the necessary documents and uploads them to SDC. At the back office, the operator downloads the application from the SDC and compares with the hard copies received from the Nemmadi centers. Validation of the application is carried out and the order for issuing the certificates is given by the higher authority at the back office. It may take few days depending upon the rush. Once the verification is over and the issue order is given, the operator at the Nemmadi center prints out the certificate and hands over the same to the requested citizen by collecting a nominal fee.

Karnataka is one of the few states, which had the unbundling of the power sector very early in 1970s in the form of Karnataka Electricity Board (KEB) for the transmission and distribution affairs and Karnataka Power Corporation (KPC), looking the generation aspect of the sector. The installed capacity along with the state share from the central generation is given in Table 1. The installed capacity the non-conventional energy sources (NCE) is high, but the electricity generated from them is far less than even the thermal sources because of many reasons. The next major share of the generation of the state comes from the hydel power (around 3650 MW), which depends on the monsoon. The thermal generation major share comes from the state's first thermal plant that is Raichur Thermal Power Station (RTPS), which has an installed capacity of 1470 MW. It is around 20 years old and facing many problems, which causes it to be operated partially. It has an average plant load factor of 81.68 in the year 2008-09, a reduction from 84.22 in 2007-08 [4].

Table 1: Power Generation (Installed Capacity) Details of Karnataka [5]

Sl. No.	Source	Capacity in MW as on 31st Mar 2013
1.	Hydel Power	3652
2.	Thermal Power	2720
3.	Diesel Plant	108
4.	NCE	4068
5.	From CGS	1836
6.	IPP & Captive	1550
Total		**13934**

The situation on the demand side is very much similar to the rest of the country. The energy shortage is a continuing affair. The figure 2 shows the increasing trend of energy shortage [7]; even though there was capacity addition during this period, but it did not suffice, because of the load growth. To fulfill the required shortage of power, the state government purchases the peak power at the highest price or overdraws the power from the national grid. This over drawl, from the grid, results in a payment made towards the energy charges at UI (Un-scheduled Interchange) rates. This is a heavy burden on the exchequer.

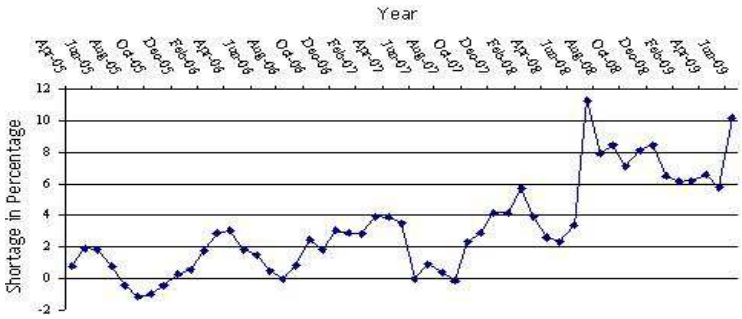

Figure 2: Energy Shortage in Karnataka from 2005 to 2009 [6]

The load shedding schedules are announced for all the consumers; generally the urban areas are less affected compared to rural areas. It used to be 20-22 hours of availability of supply in urban areas for most of the year and it would come down to 18-20 hours during summer period. In the case of rural areas the situation is very grim, throughout the year the availability of the power would be like, in a day, 6 hours of continuous 3 phase supply between 6 am to 6 pm in two batches and single phase supply from 6 pm to 6 am the next day. But the actual situation in the rural areas is much more serious. The power availability would be only for 3 to 5 hours daily and it would be less in some parts of the state. Such condition of the power availability in rural areas affected the Nemmadi project heavily.

3. SOLAR PV POWER FOR THE RURAL GOVERNANCE

The prevailing power situation in the rural areas forced the government to initiate the alternative power source scheme namely the solar PV power to provide necessary support in the Nemmadi project. A dedicated unit of independent power solutions was recommended for each of the centers in all the hoblis. The details of each of the units are as follows: A solar PV power unit of capacity 2 kWp off grid type with a generation ability to supply power to 3 computers, one printer, two fans and two 2 LED lamps for 6 hours.

The average electricity required to run the above required appliances and devices in each of the Nemmadi centers for 6 hours operation is given in table 2 below. A total of 3.32 kWh is required for the operation.

Table 2: Electricity Required for Operation in Each Center

Appliance	Rating in Watts	Quantity	Total Power in Watts	No. of Hours of Operation	Total Electricity Required in kWh
Computer	100	03	300	06	1.8
Fan	75	02	150	06	0.9
Printer	100	01	100	06	0.6
LED Lamp	10	02	20	06	0.02
Total					**3.32**

The scheme is to be supported by the government of Karnataka and executed through the state nodal agency KREDL. The estimated cost of the project was about $ 4.5 million. The cost was shared between the state government and the central government.

Even though the Nemmadi project was initiated in 2004 as a pilot project, but it was completely established in all the hoblis by 2007. The solar PV power pack project was initiated in 2012-13 and it came into operation in 2013 itself. They were made operational in all the hoblis of all the divisions. A study was conducted in three divisions of the state namely, Gulbarga, Mysore and Belgaum. The details of the number of Nemmadi centers in each of the districts of these divisions are given in the table 3.

The solar PV modules installed in majority of the centers were poly-crystalline type which has an efficiency of conversion in the range of 14-19%. The batteries supplied were maintenance free, tubular type lead acid batteries of varying capacities like 96V /150Ah or 48V/300Ah which are supplied with float valve. Each power pacs are equipped with power conditioning units which consist of Maximum Power Point Tracking (MPPT) charge controllers. The full sine wave inverters with DC input providing 230 V, 50 Hz AC output of sufficient capacity were also supplied with each pack.

Table 3: Number of Centers in Each District of 3 Divisions Considered for the Study

Mysore	Centers	Gulbarga	Centers	Belgaum	Centers
Mandya	38	Bellary	20	Bijapur	13
Mysore	27	Koppal	16	Gadag	6
C. Nagar	12	Riachur	32	Haveri	12
Kodagu	13	Gulbarga	25	U. Kannada	27
Hassan	30	Yadgir	13		
C. Magaluru	27	Bidar	24		
Mangalore	12				
Udipi	6				

The power packs were installed as per the requirement in each of the Nemmadi centers. Except for few all the units were operational. The data obtained during the operational periods of these centers was collected for a period of 5 months from February to June for the year 2013. The average values of the generation of power in these divisions, in each of the centers are plotted. The average amount electricity in kWh generated by each of the power units is found to be 3.75, as per the data collected over this period. The required electricity need (3.32 kWh) is comfortably met by the installed solar PV power units in majority of all the Nemmadi centers.

Figures 3, 4, 5 respectively show the average values of cumulative electricity generation during those 5 months in 2013 in Mysore, Gulbarga and Belgaum divisions respectively.

The electricity generated by PV power packs in the centers mainly depends on the solar irradiation falling in those places. Karnataka has good solar potential in the range of 4.5 to 6 kWh/m^2/day and it is available for almost 300-320 days [7]. In all these divisions during April and May, the generation is higher than the other months as it is summer during these months.

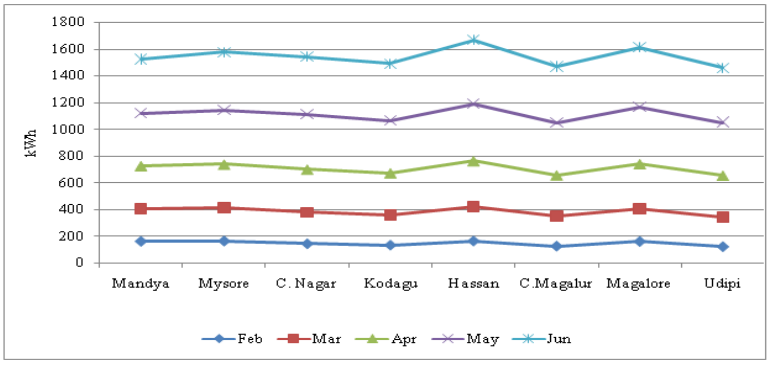

Figure 3: Average Value of Electricity Generated in All the Centers of Districts in Mysore Division

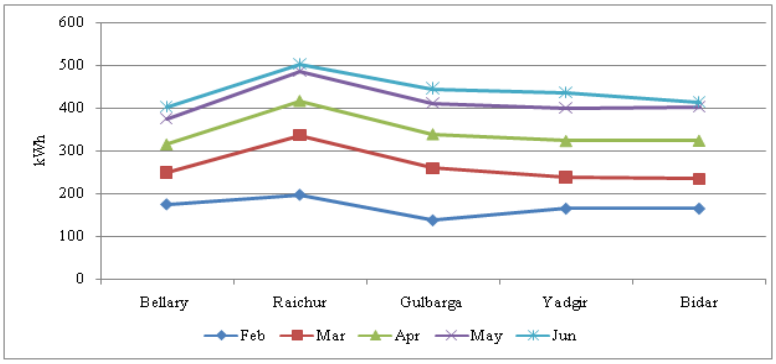

Figure 4: Average Value of Electricity Generated in All the Centers of Districts in Gulbarga Division

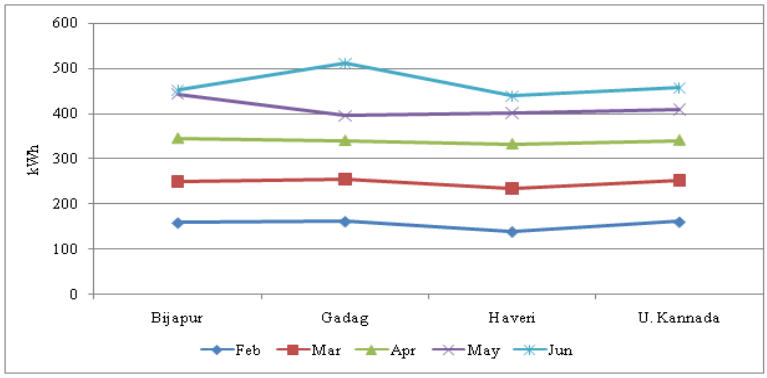

Figure 5: Average Value of Electricity Generated in All the Centers of Districts in Belgaum Division

It is observed that Gulbarga and Bijapur divisions have higher values of generation compared to Mysore, a these regions receive more radiation in comparison with that of Mysore. During all these months of observation the power units worked satisfactorily, barring few, which had some problems that are rectified.

4. CONCLUSIONS

The Nemmadi centers set up to help the governance were not performing as expected, because of the non-availability of the electricity during the working hours. The load shedding periods both scheduled and unscheduled are of very long duration especially in the rural areas. The government in association with KREDL in Karnataka initiated the establishment of solar PV power units in all these centers. These are off grid type units. The performance of these units is analysed and it is found that majority of the units are working satisfactorily along with all the accessories generating the required amount of electricty.

In the earlier system of getting the documents or certificates of interest by the people was a kind of herculean task. All the relevant documents in support of the requested certificates were to be verified manually, by searching huge volumes of records in the revenue offices. This used to take place in the taluk had quarters, and quite a lot of time was required. The time varied from weeks to months some time. So, the citizen used to visit the office quite number of times, which used to cause him financial and emotional burden. The money they used to spend was quite a lot depending on the urgency of the document. Now the citizen needs to spend one fourth of a dollar to get the required documents and without wasting much of the time as the Nemmadi centers were located nearer to his/her village. All the physical work required has now reduced to few minutes of search through the data base and printing the requested certificate.

The use of solar PV units in the Nemmadi centers has helped the state government in its governance and reduced the efforts and trouble the citizens used to take in getting the revenue documents.

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REFERENCES

1. Ministry of Power, Government of India, website http://powermin.nic.in/

2. Jeelani S. A. (ed), (2010), A Hand Book of Karnataka, Karnataka Gazetteer Department, Govt. of Karnataka, Bengaluru.
3. Aundhe M. D., and Narasimhan R. (2012), "Project Nemmadi: the bytes and bites of ICT adoption and implementation in India", Journal of Information Technology Teaching Cases, 2, 29–45.
4. Central Electricity Authority, Ministry of Power, Government of India website http://www.cea.nic.in/
5. Ministry of Energy, Government of Karnataka, website http://www.gokenergy.gov.in/
6. Karnataka Electricity Regulatory Commission website http://www.kerc.org/
7. Solar Radiation Hand Book -2008, (2008), Ministry of New and Renewable Energy, Govt. of India.