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Consumers' Behaviour towards Incentives for Solar Water Heater Use in Karnataka, India

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Abstract— ***The demand-side management (DSM) programs typically cover a variety of policies by the utilities to reduce the consumption of electricity. One such policy is to encourage the installation of appliances that use less electricity to perform their functions. In Karnataka DSM measures are in the initial stage. Electric water heating shares major portion (approximately 23%) of the electricity in the domestic sector. With the available incentives from the utility, the shift to other methods of water heating is not encouraging. This paper proposes alternative incentives which are offered to consumers to increase the penetration the solar water heaters. A survey conducted to assess the consumers' behavior is analysed for the proposed incentives.***

Index Terms—***Conservation, Demand, Heater, Solar***

I. INTRODUCTION

The power sector in India has grown manifold from an installed capacity of 30,000 MW in 1981 to over 1, 85,500 MW in 2011 (as on 30th November). This growth in supply has not reduced the problems of its power systems which are struggling to overcome chronic power shortages and poor power quality. With increasing demand that has exceeded supply, peak (around 13%) and energy (around 10%) shortages continue to plague the sector. Shortages are aggravated by inefficiencies in power generation, distribution and end-use systems. The inefficiencies in the end-use systems is due to irrational tariffs, technological obsolescence of industrial processes and equipment, lack of awareness, not yet fully developed energy services industry, and inadequate policy drivers in India [1] [2].

The poor financial condition is the elementary problem being faced by the State Electricity Boards (SEBs) or success or entities in most states. Over the years, the state utilities have been causing an increasingly larger drain on the State Government budgets, contributing to 10-15% of the state fiscal deficits adversely affecting much needed investments in the social sectors of health and education. The power sectors are operating with very low or no returns on the equity and no contribution to future investments from internal resources. This has resulted in inadequate investment in additional generation capacity. This has further aggravated the existing gap between power supply and demand.

Even if captive market capacity addition of say, 1,500-2,000 MW per year (as planned by Indian Government) is included, a total capacity addition of not more than 6,000 MW a year over the next 4-5 years would be expected. This translates into US $ 6 billion of investments and several million tons of additional pollutants but would still not be close enough to meet the targeted capacity addition to meet the current demand. The direct and indirect economic impact of outages resulting from the capacity shortages is enormous. Some of the tangible impacts range from millions of dollars of losses in the industrial sector to over sizing of pumping systems resulting in falling groundwater levels at an alarming nrate in the agricultural sector. Thus, the Indian power sector faces two fundamental and interdependent issues: inferior operational performance leading to poor revenue cash flow, and as a consequence, inadequate capital mobilization for sector expansion. Current approaches do not completely address these issues. Power sector plans focus exclusively on new supply and lately, to an extent, on improving supply efficiency and reducing T&D losses (for instance, the latter through the Accelerated Power Development Program). A major omission is the neglect of demand-side management (DSM) opportunities in India. There is a clear role and potential for utility driven DSM programs in India [3] [4]. It is estimated that the end-use efficiency improvement potential in industry and building sector alone is of the order of Rs*. 10,000 Crores** and Rs. 2000 Crores per year respectively. The new Energy Conservation legislation seeks to implement energy efficiency policies that lead to widespread market development though better standards for appliances and equipment, energy efficiency labeling, rational cost-of service based tariffs, mandatory energy audits, awareness and training, financial and fiscal incentives (eg. 100% accelerated depreciation) [1] .

II. ELECTRICITY SCENARIO OF KARNATAKA

Karnataka is one of the few states, in India, which had the unbundling of the power sector way back in 1970. The two entities were: Karnataka Electricity Board (KEB) for the transmission and distribution affairs and Karnataka Power Corporation (KPC) for the generation aspect of the sector [5]. The installed capacity along with the state share from the central generation is given in table I. The major share of the generation of the state comes from the hydro power (around 3700 MW), which depends on the monsoon. The Raichur Thermal Power Station (RTPS), which has an installed capacity of 1470 MW, is around 20 years old and facing many problems. It has an average plant load factor of 81.68 in the year 2008-09, a reduction from 84.22 in 2007-08 [6].
*55 Rs = 1 US $, ** 1 Crore = 10 Million

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Table I Karnataka Power Sector Ata Galnce As On 31-05-2012 [5]

KPC Hydro and Thermal	6005.07 MW
CGS (karnataka Share)	1700 MW
NCE, IPPS and Others	3609.10 MW
Total Installed Capacity	11314.17 MW
No. of Consumers	1.82 Crores
Length of Transmission Line	37410.14 CKMs
No. of Stations	1315
No. of DTCs	4,06,637
HT Lines (length in CKMs)	226719.46
LT Lines (Length in CKMs)	474820.66

On the demand side, the situation is not that different from rest of the country. The energy shortage is a continuing affair. The figure 1 shows the increasing trend of energy shortage [7]; even though there was capacity addition during this period. To fulfill the required shortage of power, the state government purchases the peak power at the highest price or overdraws from the grid. The overdrawal from the grid results in paying for the energy in UI rates. This is a heavy burden on the exchequer. The amount of money paid towards UI charges in 2008-09 by the state government is given in table II. The motivation for the DSM initiatives in Karnataka comes from this situation of the power in the state. To relieve the burden

on the power system the short term solution available is DSM.

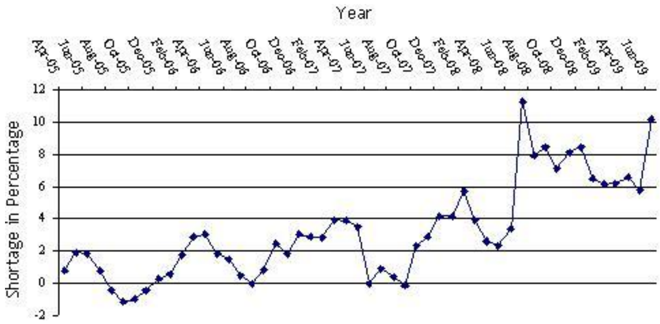

Figure.1 Energy Shortage in Karnataka from 2005 to 2009 [7]

Table II The UI Charges Paid By Karnataka In 2008-09[7]

Month	UI Energy In MU	UI Amount Rs. in Crores
April	23.979752	7.16
May	83.309754	50.42
June	126.880688	84.27
July	126.597982	112.69
August	82.377925	68.78
September	122.288561	92.04
October	142.83255	106.46
November	156.007659	134.68
December	159.152124	113.98
January	269.181047	195.61
February	150.337689	118.22
March	68.540441	45.74

III. LOAD CURVE OF GESCOM

The study is carried on the GESCOM, an electrical utility of Karnataka. The area coming under the GESCOM region (the north-east part of the Karnataka, India), consists of 6 districts. Most of them are rural and semi urban in nature and lack industries. Only Gulbarga and Bellary districts have some cement and steel industries respectively and most of these industries own their power generation. For the study, the load data of a feeder in Gulbarga is considered. The load under this feeder comprises rural, urban, commercial and some industrial installations. The data of 110 kV south Gulbarga substations in 2010 is considered for the study. The daily load curves for three different days namely, a working day, a weekend and for a holiday for the month of October are given in the figure 2.

The loads in this have exhibited typical daily curves. The morning peak (05-09 hours) and evening peaks (17-21 hours) are prominent with moderate valley portions in the afternoon and midnight. The morning peak is mainly because of the water heating. As urban and semi urban population mainly depends on electricity for their hot water requirement, leading to morning peak. In the evening urban and commercial lighting load causes evening peak [8]. Gulbarga has five 110 kV substations catering to loads in different tariff categories as given in table III.

The most of the energy consumers are in the LT-2 category and majority of these are urban domestic consumers, connected with AEH (All Electric Home, a 15 A connection) connections. This category primarily consists of middle class population residing in ever-expanding urban areas in the country. This population is typically using electrical geysers for their hot water requirement. Since this category consists of working class, electrical geysers owned by the consumers in this category operate during morning period causing demand to increase significantly during morning period. As a result, morning peak demand for most of the Utilities has been found to be between 6.00 a.m. and 10.00 a.m. These consumers consume 200 or more units per month and therefore fall in higher consumption bracket. The consumption pattern of these loads dictates the daily load curve of that distribution utility and it is very much evident from the load curves of the GESCOM.

IV. DSM OPTION

The state government purchases power at very high prices during the peak periods as mentioned. Hence there is an urgent need to bring down/reduce these peaks. The load clipping is most suitable load shape objective for this purpose. The reduction in the load is to be initiated; to do so, the load profile study is essential. In [9] the end use analysis of residential sector of Karnataka has been done. It is shown that the water heating takes the major electricity consumption among all the electrical appliances used in

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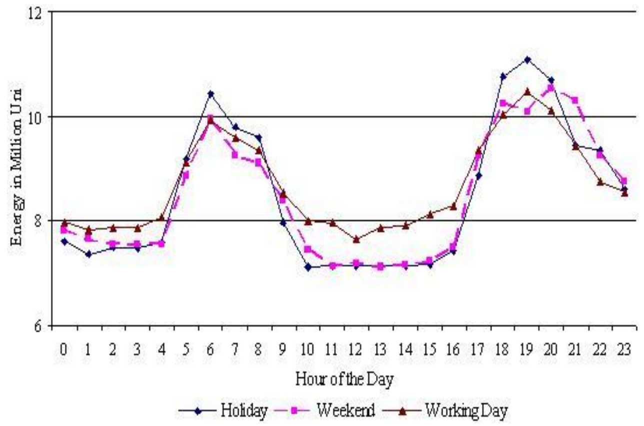

Figure. 2 Daily Load Curves of GESCOM in 2010 [8]

Table III Consumer Statistics Of Gulbarga In 2010 [3]

Tariff Category	Consumer Type	No. of Installations
LT-2	Domestic + AEH	48342
LT-3	Commercial	7536
LT-5	Up to 30 HP	717
LT-6	Street Light	363
LT-7	Temporary	883
HT-2a	Industrial	08
HT-2b	Commercial	27
HT-3	Water Supply	01

residential sector. The option available to reduce the electricity use for water heating is to change the fuel, which gives following choices:

- use of biomass
- use of solar energy

Consumers have not shown interest in biomass use; hence the use of solar energy has to be encouraged. A Solar Water Heating System (SWHS) is a device that uses solar energy to heat water and store the hot water for domestic, commercial and industrial applications. Any installation of SWHS would result in reduction in demand on electricity network. The electricity that may be saved due to installation of SWHS would result into any one of the following consequences depending upon the demand-supply scenario of the Utility.

- Reduction in load shedding for an utility during morning peak demand hours if utility is facing demand-supply gap;
- Reduction in costlier power purchase if the utility is self sufficient.

In both cases, the utility enjoys the benefit of higher margins due to either availability of extra energy to supply other categories of consumers or reduction of high cost power purchase, it also enjoys lower level of losses. In the case of Karnataka, the electricity saved due to installation of SWHS would result into reduction in load shedding during morning peak demand hours as utilities here are facing a large demand-supply gap. Most consumers in this category can afford to purchase solar water heaters. While maximum share of the current market for SWHS is held by this category of consumers, huge potential is still to be tapped. SWHS has significant potential to replace the existing electrical geyser in this category thereby clipping the peaking requirement during morning period [10] [11].

A. Incentives Offered

In India some of schemes for promotion of SWHS have been in operation for years. Most of these schemes were developed and coordinated by Ministry of New and Renewable Energy (MNRE), Government of India (GOI) and some schemes are developed at the State level.

1) Interest Rate / Capital Subsidy Financial Assistance:

Since mid nineties GOI is offering promotional schemes for SWHS. Under MNRE it provides soft loans to the users under the interest subsidy scheme through a network of financial institutions. Indian Renewable Energy Development Agency (IREDA) operates as a Nodal Agency for the scheme. Interest subsidy offered for domestic users at the rate of 2%, 3% for institutional users and 5% for industrial/commercial users. The fund management is done by IREDA. In addition, capital subsidy is available to builders & developers/ development authorities/ housing boards/ cooperatives/ Group Housing Societies for providing SWHS in new buildings and housing/ commercial/institutional complexes. The Capital Subsidy is operated by MNRE through State Nodal Agencies.

2) Capital Subsidy:

The subsidy up front will be available as follows: Non-profit making institutions: 1,750 Rs./sq.m , Profit making institutions and companies: 1,400 Rs./sq.m , Subsidies up front only for systems with a capacity of 2,500 litres per day (approx. 20 sq.m) or more: Housing complexes: 1,900 Rs./sq.m, Institutional and commercial buildings: 1,750 Rs. /sq.m (Both of the above categories are not entitled for soft loans).

3) Amendment of Building bye-laws:

In a separate initiative, a model regulation / building bye-law for mandatory installation of SWHS in new buildings was circulated by the Ministry of Urban Development to all States and Union Territories with a request for onward circulation to all local bodies for incorporation in their building bye-laws. Necessary orders have been issued in 19 States and 41 Municipal corporations / Municipalities have so far amended their building bye-laws. A few municipal corporations are providing 6-10% rebate in the property tax for users of solar water heaters. Some of the states like Karnataka, Gujarat and others have amended the building bye-laws.

4) Rebates for SWHS in Karnataka [7]:

In Karnataka, the SWHS user receives rebate in monthly bill, in Rupees per unit of electricity consumed subject to maximum value of the rebate. The units of electricity saved are calculated on pro rata basis referring to the guideline that the SWHS of 100 liters capacity replacing an electric geyser in domestic use saves 1500 units of electricity annually. Further, though rebate is defined in terms of Rs per Units of electricity saved, in reality the rebate is applied on the basis of Rs per units of electricity consumed with maximum electricity savings (represented in terms of maximum rebate) or maximum electricity consumption in a month (as rebate can not be more than the monthly bill of the consumer) acting as upper limits for rebate. While Karnataka Electricity Regulatory Commission (KERC) has not referred to any particular features of the SWHS as reason for giving rebate, but Karnataka Renewable Energy Development Limited (KREDL) refers to following features of the SWHS.

- Fuel Saving: A 100 liters capacity SWHS can replace an electric geyser for residential use and saves 1500 units of electricity annually
- Avoided Utility Cost of Generation: Use of 1000

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SWHSs, with each of 100 liters capacity, can contribute to a peak load shaving of 1 MW.

- Environmental Benefits: A SWHS of 100 liters capacity can prevent emission of 1.5 tons of CO_2 annually.

From 2006, KERC has given the orders for the rebate to be offered by all the distribution companies in Karnataka, as 50 paise per unit subject to a maximum of Rs. 50 per month per installation and the same is also applicable to all the installations under LT-2 category. The same rebate is continued for 3-year control period of FY 2007-08 to FY 2009-10. It has been observed that consumers have been asking for the increase in rebate so that consumers will have enough motivation for installation of SWHS and KERC has been assessing the need of fulfilling such demand.

B. *DSM Survey*

To analyse the impact of the incentives on the use of SWHs, a survey was conducted. The survey was done in two cities Gulbarga and Bidar belonging to GESCOM region. These two places have more urban and semi urban population respectively. The data was collected for a total of 1130 households of which 678 (around 60%) belong to Gulbarga and 452 to Bidar. A questionnaire was given to the owner of the house (decision maker) and all the details are collected. The details of the samples are given in table IV. The households contacted in survey are more in the annual income range of Rs. 0.2-0.75 million and belong to L-2 category.

The houses already having SWHS are only 218 (around 19% of the surveyed houses). There is a major share of houses in the surveyed lot which do not own SWHS. The survey focused on the issues related to incentives that motivate the head of the house to install the SWHS. Incidentally, all the respondents showed their willingness towards the purchase of SWHS, but quoted the high price and the tangible benefits they would get after owning it. In the survey the consumers were asked to provide relevant information regarding their income, connected load/load demand and were asked to prioritize their response based on their perception. In table the details of the survey are given. The respondents gave additional formation along with the questionnaire. Most interestingly many of the consumers, even though, well educated are unaware of the present incentive offered by the ESCOMs for the usage of the SWHS. The consumers belonging to the high income group were in favour of the first two incentives. As they are well to do, who can afford to purchase as well as pay any price for the electricity. Many of the consumers of this category, incidentally did not own a SWHS, but are ready to own, expecting any of the above two incentives. The consumers, who favoured low interest loans from the banks mostly, belonged to salaried class. The consumers, who wanted to reap the benefits for longer period, opted for the rebate on electricity prices, more than the prevailing rebate. These consumers belonged to semi urban area. The majority of the consumers were of the opinion that the price of the SWHS is the major barrier for its usage. Hence 1050 (93%) out of 1130, of consumers wanted the subsidies to be increased on the SWHS. This is the major point all most all the consumers agreed upon. There is one surprising opinion by some of the consumers that is they would purchase the SWHS, as and when the price of the electricity becomes too high. The consumer's responses pointed at the lack of information provided by the governments, utilities regarding the incentives offered by them. Majority of the respondents are willing to participate in the energy efficiency initiative.

Table IV- Details Of The Survey

Expected Incentive	No. of Consumers
Reduction in the taxable income	90
Property tax reduction	10
Low interest loans from the banks	289
Rebate in the electricity charges	867
Subsidy on the SWHS	1050
Hike in the electricity price	610

V. CONCLUSION

The incentives offered to encourage the use of energy efficient and or renewable energy based devices are not encouraging. In the present scenario of supply not meeting the demand, the short term solution will be DSM. In this context the reduction of morning peak demand in the urban and semi urban areas of Karnataka can be achieved, motivating the consumers to go for SWHS as in the morning, water heating consumes more power. To understand and analyse the consumer's behaviour towards the purchase of SWHS in the region of GESCOM was studied by getting the data of responses of consumers. Majority of the consumers have opined for the cost reduction of the SWHS, the subsidies offered presently have to be increased. The utility and the governments should consider these facts and formulate policies in this regard to motivate the consumers to install SWHS and increase the penetration of the same.

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