THE IMPACT OF A COST REBATE OF THE ECONOMICS OF SOLAR POWER IN INDIA

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***Abstract*— The primary economic reality of vestige fuels is that such fuels are found only in a moderately small number of locations across the world, yet are consumed everywhere. The financial reality, by contrast, is that solar property are available, in varying degrees, all over the world. Fossil fuel and solar resource use are thus poles apart – not just because of the ecological effects, but also because of the primarily different economical, logical and differing political, social and cultural cost. These differences must be approved if the full spectrum of opportunity for solar property is to be exploited. Therefore, this study concentrates on solar power as a renewable source of energy. It has many benefits compare to fossil fuels. It is clean and green, non-polluting and endless energy. For this reason it has fascinated more attention than other alternative sources of energy in recent years. Many energy economists say that solar energy is going to play an increasingly important role in all our lives. To highlight the importance of such a source of energy becomes not only important but also inevitable. This paper analyzes the determining factors of solar energy usage and also analyses the cost advantage of the different solar energy devises usage.**

***Index Terms*—Solar energy, electricity, cost benefit.**

I. INTRODUCTION

The Sun is our near star and it is the source of energy for life on Earth. It is about 150 million km away a space which sunlight cover in 8 minutes. The Sun is about 3, 00,000 times heavier than Earth. The energy output, solar constant is about 3.8 X 10^{33} ergs / sec. within forty minutes of the sun clean on the Earth, the Sun will have given off as much energy as the entire world inhabitants will use in a year. Only about one percent of this energy put out by the Sun is harness and utilized by earth’s population.

The fundamental energy source for the Sun is nuclear fusion, which uses the high temperatures and densities within the core to fuse hydrogen, produce energy and creating helium as a result. The Sun has been producing its sunny and thermal energies for the past four or five billion years. It has sufficient hydrogen to continue producing for another hundred billion years. conversely, in about ten to twenty billion years the surface of the Sun will begin to expand, persistent the inner planets including Earth [1]. It is stable, it is the ideal size, and it produce just the right amount of energy. For good reason, it has been called ‘Power House ’[2].

Solar power can be harness in two ways, in the form of heat (or thermal energy), and in the form of light energy. The light rays of solar energy are harnessed for power production through solar cells and are called Solar power. Photovoltaic (SPV) systems, where light is openly converted into electricity using silicon (solar) cells. The electricity thus generate can be used for lighting or other electrical application [3].

The utilization of solar energy as a power source is not a new one. Solar energy skill has different set of dynamics from other conventional energy sources. Solar plans have the heat storage and thus, generate power even after sunset. In solar energy there is also an added occasion of locally sourcing raw material at a reasonable cost. It has and supplementary advantage of being able to produce electricity right after the construction of the collector. In other technologies, there is typically a gap between plant construction and production of electricity, which increases the interest cost to funds made.

On a country-wise beginning, growth in solar capacity has been mainly driven by Spain, Germany, Japan, the US and Italy. Germany has seen extraordinary growth in the solar PV market and has reached a capacity of 5,337 MW.

The geographical focus of solar PV manufacturing is thus gradually shifting towards developing countries such as China, India, Malaysia and Taiwan. Among other things, this is due to the perceived advantages of technical manpower and labor costs that these regions offer [4].

II. PROGRESS OF SOLAR ENERGY IN INDIA

In the area of solar energy, India has today achieved a foremost position in the world in the expansion and use of technology. It is the second largest manufacturer in the world of crystalline silicon modules. Solar device based industrial production has touched a level of 7 MW/year.

Table I shows the cumulative achievements of solar device installed from 1996 to 2010. There were 3, 64,354 sq.m area covered by Solar water heaters and 4, 06,642 solar cookers were utilized in the country. This achievement rate increased progressively by the policy of the government of India.

This it seems that reveals with the current status of solar device installation. During 2010, 3.25 million sq.m areas have been covered by solar water heater devices installation. In the same year, 6, 00,072 lakh solar cookers have been distributed for usage. Under solar photovoltaic programme 792,285 numbers of solar lanterns, 88,297 numbers of solar street lighting systems and 5, 50,743 numbers of solar home lighting have installed. Besides these achievements 7247 numbers of solar water pumping installed for the benefit of agrarian society. More than 12.67 MW have so far been installed for voltage support for weak grids, for peak load saving and as diesel saving. This shows solar device technology not only entered into heating and lighting but also it extends its possibility in the area of water pumping and power producing through grid and off-grid.

TABLE I: ACHIEVEMENT OF SOLAR DEVICE IN INDIA (1996 TO 2010)

Source/ systems	Units	Achievement up to 1996	Achievement up to 2005	Achievement up to 2007.	Achievement up to 2010.
I. Solar thermal Systems					
(i). Solar Water Heater	Sq.m	3,64,344	1 million collector area	2 .15 million collector	3.25 million collector area
(ii.)Solar Cookers	Nos.	4,06,543	5,75,000	6,20,000	6,00,072
II.Solar Photovoltaic Systems					
(i) SPV Lantern	Nos	81,059	5,60,290	5,85,001	7,92,285.
(ii) SPV Street lights	Nos	32,870	54,795	69,549	88,297.
(iii) SPV Home lights	Nos	37,359	3,42,606	3,63,399	5,50,743.
(v)SPV Pumps	Nos	1,820	6818	7,068	7,247
III. SPV Power plants					
(a) Grid connected		-	-	2.12 MW	10.28 MW
(b) Stand alone		909.3 KWp	1566 KWp	2.18 MW	2.39 MW

Source: Annual reports of MNES, Government of India' 1996, 2005, 2007&2010.

A. Sample Size and Area of the Study

The examiner tries to probe into sustainable energy features by touching upon the global picture, trickle down to India's position and further narrowing down to Tamil Nadu ending with the micro study of Mumbai and Nagpur districts. Therefore, this study attempts to find out whether solar energy devices are economically viable to the users. It tries to bowl light on the cost of solar energy devices like solar water heaters and solar photovoltaic street light etc. and their benefits to households and corporate. Hence chief data has been collected through interview and questionnaire methods. The total sample size is 296 users of solar energy devices. For selection of samples, the purposive sampling technique has been adopted. Purposive sampling has been purposely used in the place of popular methods such as multi-stage stratified random sampling technique. This purposive sampling method might seem incongruous, but has been intentionally used in order to overcome the handicaps which might arise if there is any pertinent absence of sampling techniques in other sampling frames.

B. Objectives of the Study

To study the determining factors behind the adoption of solar energy in the study areas, and

To analyze the social cost benefits of solar energy in the study area.

C. Hypotheses:

There is no significant difference between the benefits in using Solar Water Heaters and Solar Street Lights.

III. RESULT AND DISCUSSION

Energy in the form of heat is an important requirement in domestic, agricultural, industrial and commercial sectors of our economy. In the house sector, thermal energy is needed for cooking, heating water and for drying purposes. In the industrial sector there is a need for hot water for cooking to provide food preparation to the workers, for cleaning purposes, for different stages of manufacture etc. In the commercial sector viz., hotels, hospitals, offices, hostels etc. need thermal energy for variety of applications like cooking, laundry and steam for sterilization, kitchen activities, washing and bathing etc. Normally, these requirements for both domestic and corporate sectors are being met by burning of coal, wood, kerosene, LPG and use of electricity. Many of these conventional sources of energy can be replaced by solar energy.

Various solar and photovoltaic devices and systems are available and are proven to be useful in the field. They have been commercialized and are finding wide and increasing applications. The benefits thus accrued through application of solar devices comprise the crux of this research study.

TABLE II: USAGE OF SOLAR DEVICE

S. No	Usage	Domestic		Corporate		Total
		Dswh	Dssl	Cswh	Cssl	
1.	Cooking			15 (34.8)		15 (5.1)
2.	Bathing	200 (100.0)		28 (65.1)		228 (77.0)
3.	Washing	200 (100.0)		28 (65.1)		228 (77.0)
4.	Cleaning	200 (100.0)		28 (65.1)		228 (77.0)
5.	Lighting		10 **(100.0)**		43 **(100.0)**	53 (18.0)
Total		**200 (100.0)**	**10 (100.0)**	**43 (100.0)**	**43 (100.0)**	**296 (100.0)**

Source: Compiled by researcher from collected data

It is observed from the table that solar energy is put to five types of uses namely as cooking, bathing, washing, cleaning and lighting. Among the users in the domestic sector which consists of 200 respondents, all respondents used solar water heater to best use for bathing, washing and cleaning purposes, and 10 user respondents of domestic solar street lamps in this sector used it for lighting purpose. The corporate sector finds extensive use of solar water heater for various uses. Thus, it is clear that to achieve the mission of facing energy crisis, vision directed towards solar devices is the path breaking solution. Solar devices has 100 percent utility value when installed and tapping this form of energy will not only enhance utility for the user in terms of monetary benefits but also the economy in giving

its people a pollution free, environmental friendly energy. Sustainable development of the country automatically takes place since such energy provides an unpolluted environment for the future generation.

TABLE III: MOTIVATIONAL FACTORS FOR USAGE

S.No.	Motivational Factor	Domestic		Corporate		Total
		DSWH	DSSL	CSWH	CSSL	
1	Subsidy	3 (60.0)	-	2 (40.0)	-	5 (100.0)
2	Space In Building	9 (47.4)	-	-	10 (52.6)	19 (100.0)
3	Easy to operate	9 (100.0)	-	-	-	9 (100.0)
4	Less Laborious Work	23 (88.5)	3 (11.5)	-	-	26 (100.0)
5	No Loss of time for Fuel collection	14 (100.0)	-	-	-	14 (100.0)
6	Scarcity and high cost of LPG	18 (94.7)	-	1 (5.3)	-	19 (100.0)
7	Scarcity of Electricity	79 (64.8)	4 (3.3)	16 (13.1)	23 (18.9)	122 (100.0)
8	Economical	13 (86.7)	-	2 (13.3)	-	15 (100.0)
9	Inspiration From others	12 (100.0)	-	-	-	12 (100.0)
10	Pollution Free Environment	20 (64.5)	1 (3.2)	-	10 (32.3)	31 (100.0)
11	Mandatory	-	2 (8.3)	22 (91.7)	-	24 (100.0)
Total		**200 (67.6)**	**10 (3.4)**	**43 (14.5)**	**43 (14.5)**	**296 (100.0)**

Source: Compiled by researcher from collected data

As given in Table III the study has identified as many as eleven motivational factors prompting the users to choose solar devices. The analysis reveals that for 122 user respondents of the users motivated due to the scarcity, high cost of electricity and LPG that prompted them to switch to solar devices. It is also revealed that solar energy is pollution free environment has been the second major motivating factor among 31 user respondents. This is followed by the reasons of less laborious work and mandatory rule to use the devices respectively for 26 and 24 user respondents. Other sources of motivation such as space in building, economy, no loss of time for fossil fuel collection, inspiration from others, easy to operate and subsidy etc. have given their lending hands almost equally in motivating the respondents to install solar devices. Thus, motivation clubbed with spreading knowledge of solar devices and the basic need in increasing the educational standards of the people will help in the better understanding and utilization of solar devices by the common man.

The cost benefit analysis of Evacuated tube collector of solar water heater for various sizes is presented in Table IV. It is revealed that the benefit cost ratio of all the sizes were greater than unity. The rate of return was higher (41percent) in the case of 4000 LPD, compared to other sizes. On the whole it is accepted that all the sizes of the Evacuated tube collector of solar water heaters are economically viable to the respondents in the study area.

TABLE IV: SIZE WISE ECONOMIC ANALYSIS OF THE EVACUATED TUBE COLLECTOR SOLAR WATER HEATER

S.No	Size	Benefit Cost Ratio (Rs)	Net Present Value (Rs)	Internal Rate of return
1.	100LPD	1.67357519	13,804	14
2.	200 LPD	1.93904271	33185.3	19
3.	300 LPD	1.92709777	49455.1	19
4.	500 LPD	2.61515507	140999	35
5.	1000 LPD	2.7798576	292342.5	40
6.	1500 LPD	2.77985703	438514	40
7.	2000 LPD	2.75181182	581337	40
8.	2500 LPD	2.75737648	727508.75	40
9.	4000 LPD	2.76904277	1166804	41
10.	5000 LPD	2.75737561	1455017	40

TABLE V: SOLAR STREET LIGHT COST BENEFIT ANALYSIS

	Total cost (a)	Discounted Factor (b)	Discounted Cost (a x b =c)	Total Benefit (d)	Discounted Benefit (d x b = e)	B – C (e – c)
1	23000	0.9099	20927.7	526	478.6074	-20449.093
2	0	0.826	0	526	434.476	434.476
3	0	0.751	0	526	395.026	395.026
4	3000	0.683	2049	526	359.258	-1689.742
5	0	0.621	0	526	326.646	326.646
6	0	0.564	0	526	296.664	296.664
7	3000	0.513	1539	526	269.838	-1269.162
8	0	0.467	0	526	245.642	245.642
9	0	0.424	0	526	223.024	223.024
10	3000	0.386	1158	526	203.036	-954.964
11	0	0.35	0	526	184.1	184.1
12	0	0.319	0	526	167.794	167.794
13	3000	0.29	870	526	152.54	-717.46
14		0.263	0	526	138.338	138.338
15		0.239	0	526	125.714	125.714
Total			**26543.7**		**4000.7034**	**2542.997**

Table V shows the details of solar street light, collected from the user respondents in the study area. From the data it can be inferred that solar street light is not economically feasible. The Payback period and discounted costs are higher than the discounted benefits. The researcher has not calculated indirect benefits of solar street light i.e., carbon emission of electrical bulb, which is not the focus of this study. Probably, if this aspect were to be taken into consideration, this too might yield benefits. Hence the null hypothesis is rejected. The researcher has accepted the alternative hypothesis that there is a significant difference between the benefits in using solar water heaters and solar street lights. From 5.2.23 to 5.2.25 tables shows that there is a significant difference between the benefits in using solar water heaters and solar street lights.

IV. CONCLUSION

The solar water heater technology and devices are justified in all the four counts – Payback period, Benefit cost ratio, Net present value and internal rate of return. Therefore solar water heater can be substituted for conventional type of water heaters. It is a feasible investment. Even though the cost of equipment owned by the beneficiary is higher, the benefits reaped by the users are not only a great boon to them but also to the government and the society to a great extent. Ultimately, the solar water heater saves the scarcest resources of nature.

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