Unleashing Nature's Power in Residential Sector- An Another way to Save Energy Resources: An Empirical Study

Tejveer Singh Anand, Satinder Singh

ABSTRACT-Residential sector is one of the prime area where energy saving can be implemented under win-win situation by installing solar street lighting system. Manufacturers, Suppliers, promoters and even Govt. bodies may take a lead part as being undertaken for the Govt. organizations / installations through DGS&D rate contract with subsidized rate for residential sector too. An empirical study has been conducted from ten different housing societies of Ahmadabad urban area those covered under co-operative housing societies and researchers found that there are lots of scope to save energy by just switching over to solar street lighting system with LED lamps from the conventional street lighting that will not only boost towards renewable energy use but saves lots of energy resources whether it is coal or oil as input fuel to thermal power plant.

Keywords: - Solar Street Lighting, Solar Cell, LED Lamps, Residential sector

I. INTRODUCTION

Energy Outlook 2035reveals that "Primary energy demand has increased by 41% between 2012 and 2035, with growth averaging 1.5% per annum (p.a.). Growth slows, from 2.2% p.a. for 2005-15, to 1.7% p.a.2015-25 and just 1.1% p.a. in the final decade". Refer Fig 1. ((http://www.slideshare.net/BP_plc/bp-energy-outlook-2035-2014-booklet?related=1) [8]

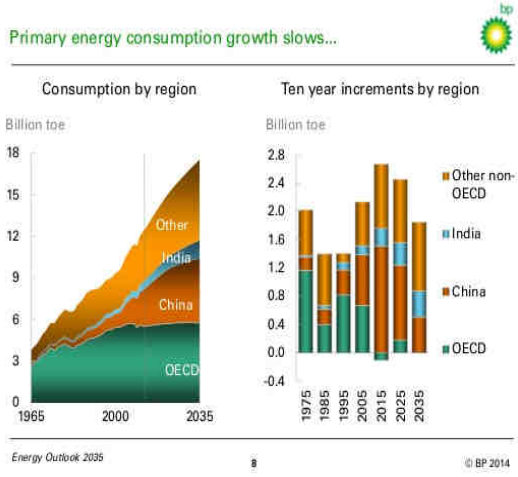

FIGURE 1: Primary energy Growth

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Tejveer Singh Anand, Student of B.Tech (Electrical) III[rd] Year, SardarVallabhbhai National Institute of Technology (SVNIT), Dept. of Electrical Engineering, Surat, Gujarat, INDIA.

Satinder Singh, Pursuing PhD in Management from Gujarat University, Working as Deputy General Manager (Drilling), Oil and Natural Gas Corporation Limited ONGC), Cementing Services, Ahmedabad Asset and a Certified Energy Auditor- BEE, Ministry of Power, GOI, INDIA.

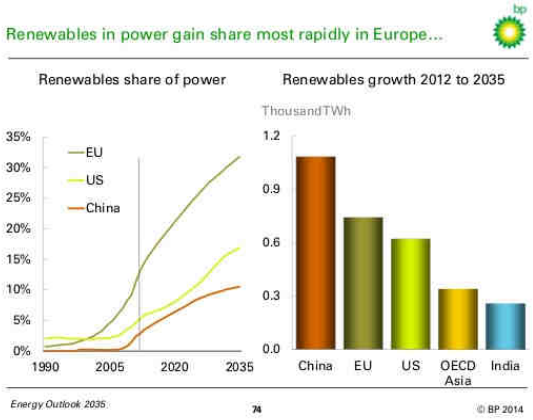

FIGURE 2: Renewables in Power gain

Energy Outlook 2035 further pointed out that "India's demand growth, in contrast, remains robust; rising from 142Mtoe (5.9% p.a.) in 2005-15 to 159 Mtoe (3.0% p.a) in 2025-35 as the country's industrialization continues (Refer Fig 2). In the final decade India replaces China as the leading source of coal demand growth." (http://www.slideshare.net/BP_plc/bp-energy-outlook-2035-2014-booklet?related=1 Page69) [9]. "The primary energy demand in India has grown from about 450 million tons of oil equivalent (toe) in 2000 to about 770 million toe in 2012 [and] this is expected to increase to about 1250 (estimated by International Energy Agency) to 1500 (estimated in the Integrated Energy Policy Report) million toe in 2030".(http://powermin.nic.in/Energy-Efficiency)[6]. As far as renewable energy is concerned, solar energy has huge potential and its use is growing fast, yet in many quarters it is still viewed with concern about costs and doubts over efficacy. All countries and economies stand to gain by understanding solar energy's potential to fill a very large part of total energy needs economically, in a secure and sustainable manner in the future. It can also help to reduce the greenhouse gases (GHGs) that threaten irreversible climate change for the planet [10]. To cope-up the demand there is a need to realize to have alternative sources of energy to keep optimum impact on Import bill. Thinking to switch over to the street solar lighting is one of the ways to contribute in line. However, Govt. of India has already planned and as revealed "Energy Efficiency improvement projects in street lighting are being carried out by M/s EESL in 9 states replacing old in- efficient street lights with energy efficient LED based street lights on ESCO business model".(http://powermin.nic.in/Energy-Efficiency)[6]."Solar energy offers a clean, climate-friendly, very abundant and inexhaustible energy resource to mankind, relatively well-spread over the globe. Its availability is greater in warm and

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sunny countries – those countries that will experience most of the world's population and economic growth over the next decades". (www.iea.org/publications/.../solar_energy_perspectives2011.pdf) [7].

In spite of Govt. of India's initiation to various street solar lighting project, this is a time to realize that every citizen of India to promote solar lighting by way of installing solar street lighting arrangements in and around their housing societies which not only affects the energy saving in totality but decrease their monthly burden of energy bill.

II. SOLAR STREET LIGHTING

The growth of the global PV market has been impressive since 2003, with an average annual growth rate of 40% to 2009, and about 135% in 2010. The cumulative installed global PV capacity grew from 0.1 GW in 1992 to 40 GW at the end of 2010, with 42% being installed in 2010 alone [10] (Figure 3).

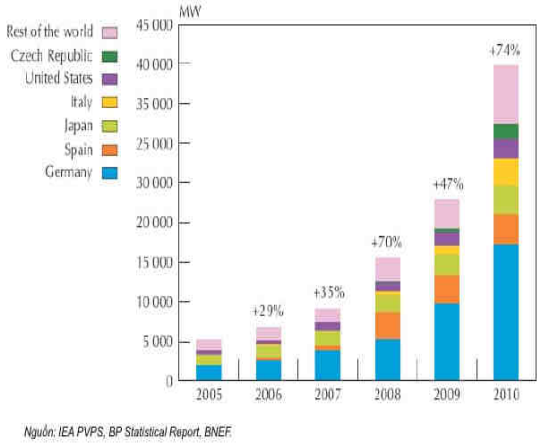

Figure 3 Global cumulative PV capacities by 2010

However, to promote green energy environment, our Hon'ble Prime Minister Shri Narendra Modi has announced to have a target of 100000 Mega Watt solar power generation with first initiation from Gujarat covering five districts; Patan, Banaskantha, Mehsana, Kutch and Morbi [1].The solar street lighting system operates from dusk to dawn i.e., the lamp is automatically switched ON and OFF as per sunset or sunrise. The street lighting system basically consists of SPV Module, Low maintenance battery, LED Lamp, Pole, Battery box, interconnecting cables with an average market cost of approximate Rs. 20,000.00 per set of individual street light with a pole of 4meter height , 110 v PV, 128A battery , 20 W LED Lamp including cabling and labour cost involved for its installation. However, it can be reduced to Rs. 15000.00 per pole approx. if it is being installed through centralized paneling with battery bank. However, The PV industry has witnessed significant cost reductions in only the last three years (IEA 2011, p.60). "Since the beginning of 2010, solar panel prices have dropped by 30%, and costs continue to fall. The United States was a net exporter of solar products in 2010 by $2 billion -- even to China. Solar power in the U.S. now exceeds 3,100 megawatts, enough to power more than 630,000 homes". [11]

III. EMPIRICAL STUDY

Empirical study has been conducted from ten different cooperative housing societies of Ahmedabad urban area which have 50 houses at an average and as surveyed there are average 16 street lights (ranging from 12 to 18 nos. having CFL lighting installed on a pole). Table 1 reveals that the initial cost of installation of solar street light is 2.28 times to conventional street light.

Table 1: Standard Cost Comparison: Conventional Street Lighting Vs Solar Street Lighting

DESCRIPTION	CONVENTIONAL STREET LIGHTING			SOLAR STREET LIGHTING			
	Availability	Cost (In Rs.)	Total cost for 16 Nos. of Street Lights	Availability	Cost (In Rs.)	Total cost for 16 Nos. of Street Lights#	Average cost per Pole
Standard Pole	YES	3500	56000	YES	2500	40000	238696/16= 14919
Luminaire	YES -50W CFL	750	12000	YES – 20W LED	2386	38176	
Lamp Cover With Stand	YES	500	8000	NO	0	0	
Panel	NO	0	0	YES-		79000	
Battery Bank	No	0	0	YES- 12V, 128Ah		52000	
CABLE- 15 m	YES	345	5520	YES	345	5520	
MCB With Box	YES	440	7040		0		
Standard Installation	YES	1000	16000	YES	1500	24000	
Total Cost		**6535***	**104560**			**238696**	**14919***

considering centralized paneling at the highest residential point Source: Primary data/secondary data through Survey *Market Rates excluding taxes

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Table 2: Operating Cost: Conventional Street Lighting Vs Solar Street Lighting

CONVENTIONAL STREET LIGHTING							SOLAR STREET LIGHTING					
Wattage	Energy Consumed / day (considering 9 hrs of operation)	Nos. of installed Pole in a residential society (at an Average)	Total Energy Consumed per day	Cost per KWh (InRs.) Considering average 216 KWh consumption per Month	Total Cost per day (In Rs.)	Energy Cost per Month (In Rs.)	Wattage	Energy Consumed / day (considering 9 hrs of operation)	Nos. of installed Pole in a residential society (at an Average)	Total Energy Consumed per day	Total consumption per Month	Total Cost per Month
50 W - CFL	0.45 KWh	16	7.2 KWh	3.85[#] (Excluding other charges)	27.72	831.60	20 W- LED	0.18	16	2.88	86.4 KWh	0.00
Total Electricity charges per year = Rs. 9979.2[$]							Total Electricity charges per year = Rs. 0.00					

(# Source: http://www.ugvcl.com/petition/Tariff_Schedule.pdf Point No.1.2, page 93) Source: Primary data/secondary data through Survey
$ excluding other mandatory charges

Table 2 illustrate the comparison towards operating cost of both the arrangementsand as analyzed there is an average consumption of 831.60 KWh energy per month with existing arrangement of conventional street lighting amounting to Rs. 9979.20 per year where as there are no operating cost involved in solar street lighting being natural resource of energy.

Table 3: Recurring Expenditure on Conventional Street Lighting and Solar Street Lighting

Items	Conventional Street Lighting					Solar Street Lighting					
	Average life (in Years)	Unit Cost	Replacement cost for 15 years	No of Poles	Total cost	Items	Average life (considering 9 hours of operation)	Unit Cost	Replacement cost for 5 year	No of Poles	Total cost
50 W- CFL	1.5	750	7500	16	120000	20W-LED street light Luminary	50000 operating hours > 15 years	2386	0.00	16	0.00
Total Recurring Expenditure (in 15 years)					**120000**	**Total Recurring Expenditure (in 15 years)**					**0.00**

Source: Primary data/ secondary data through Survey

Considering the life span of 20 W LED for solar street lighting, the recurring expenditure has been worked out in Table 3. As analyzed, there are expenses of Rs. 1.2 Lakhs for replacement of CFL in conventional street lighting whereas batteries installed with solar lighting arrangement needs replacement with time. However, as surveyed batteries covers 05 years warranty and an expenditure of Rs. 1.56 Lakhs approximate would be involved for replacement of batteries thrice in 15 years (Refer table 4).

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Table 4: Saving in Terms of Rupee by Switching to Solar Street Lighting

CONVENTIONAL STREET LIGHTING				SOLAR STREET LIGHTING			
Description	**Terms**	**Cost From table 1 & 2**		**Description**	**Terms**	**Cost From table 1 & 2**	
		yearly	**Total**			**Yearly**	**Total**
Total cost of installation	One time		104560	Total cost of Installation	One time		238696
Recurring Expenditure for CFL & MCB	15 years		120000	Recurring Expenditure for Battery	15 years	52000 (once in 5 years)	156000
Electricity Charges	15 years	9979.2	149688	Electricity Charges	15 years		0.00
Total Cost for 15 years			**374248**	**Total Cost for 15 years**			**394696**

Source: Primary data/ secondary data throughSurvey

Table 4 reveals that an amount of Rs. 394696.00 would be involved for installation of solar street lighting with centralized panel and battery bank whereas Rs. 374248.00 would be expenditure to maintain the existing conventional street light for a span of 15 years.

IV. DISCUSSION

Research finds that there is no such benefit to the individual concern to switching it over to solar street lighting from the existing conventional street lighting with CFL for their residential societies.

However, to have ultimate concern to save energy resources, following have to be looked after:

- Switching to solar street lighting may save 216KWh x 12 = 2592 KWh per year per housing society
- 2592KWh x 15 years = 38880 KWh of Energy unit
- Considering 40% efficiency of the thermal Plant(http://www.brighthubengineering.com/power-plants/72369-compare-the-efficiency-of-different-power-plants/) [3] it comes to 97200 KWh to get production 38880KWh.
- However, in terms of fuel input it comes to 97200 KWh/ 1904 = 51 ton of coal equivalent.
  (KWh generated per unit of fuel used: 1,904 kWh per ton, 0.95 kWh per pound, of coal) (http://www.eia.gov/tools/faqs/faq.cfm?id=667&t=2) [4]
  = 51 x 4,056.12 = Rs. 206862.12

  (Considering Cost of coal= 4056.12 per MT as on March 2015)(http://www.indexmundi.com/commodities/?commodity=coal-australian&currency=inr) [5]

However, Considering 72, 14,225 of Actual population of Ahmedabad (http://www.census2011.co.in/census/district/188 ahmedabad.html)[2] with an average of 4 persons in a house, there would be approximate 18.04 Houses in Ahmedabad Urban Area. However, as surveyed in ten different societies there are average 50 houses which form a housing society. Thus total housing societies comes to 1804000/50 = 36080 housing societies approximate.

Total saving of coal = 36080 x 51 = 1840080 MT amounting to Rs. 74635.85 Lakhs may be saved just from Residential sector of Ahmedabad alone by switching over to solar street lighting from conventional street lighting in a span of 15 years which comes to Rs. 4976 Lakhs approximately per year.

V. CONCLUSION

It is the time to think towards the saving of energy resources amounting to Rs. 4976 Lakhs per annum by just switching over to solar street lighting from residential area from one city only. Authorities concerned have to promote solar street lighting for residential societies as there is no motivational factor for individual concern being no financial gain from switchingto solar street lighting. Since, housing societies are mostly covered under co-operative housing societies, the subsidies to promote for installation of solar street lighting may be undertaken as per the scheme already developed for laying concrete roads, street lighting etc. within the housing societies under Swarnim Jayanti Mukhaya Mantri Shahari Vikas Yojana (SJMMSVY)(http://www.gmfb.in/project-detail.php?id=3) [12] that too under 80:20 ratio where 80 % of the total expenditure is born by municipal corporation and only 20 % are being burdened to societies. This scheme has widely been accepted and maintained on priority that is under first come first serve basis.

20% of total expenditure born by individual society would come to Rs. 47739.00 (from table1) and could be compensated within 4.78 Months against the electricity charges being paid by the society per month (Refer table 2)

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Tejveer Singh Anand He is a student of B.Tech (Electrical) IIIrd Year, SardarVallabhbhai National Institute of Technology (SVNIT), Dept. of Electrical Engineering, Surat, Gujarat, INDIA and having Lean Six Sigma-Yellow Belt. He has already published a Research Paper in International Journal of repute.

Satinder Singh He is working with Oil and Natural Gas Corporation Limited ONGC), Cementing Services, Ahmedabad Asset as Deputy General Manager (Drilling) and pursuing PhD in Management from Gujarat University. He is having the qualification of BE (Mech), MBA (Mktg), MIMA, PGCPM, Certified Energy Auditor (BEE)-EA-10341, Lead Auditor OHSAS 18001:2007, Lead Auditor EnMn ISO 50001:2011 and Lean Six Sigma- Yellow Belt with 31 years of Industrial experience. He has published 06 Research papers in International and National Journals of repute.

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