A Study of Solar Energy and Ways to Improve its Economic Viability and New Business Scopes - Review

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ABSTRACT: Energy supplies from renewables such as from biofuels, solar heat, photovoltaics, wind, hydro, wave, tidal, geothermal, and ocean-thermal are essential components of every nation's energy strategy, not only because of concerns for the local and global environment, but also for energy security and sustainability. Solar energy, amongst other renewable sources of energy, is both promising and freely available energy source. It has the capacity for managing long term issues in energy crisis. The fast growth in area of solar technologies comes with various pitfalls. It is limited by the technology of the time which includes low efficiency of solar cells, economic hindrances for example high upfront costs and a dearth of financing processes and technical obstacles which include old and inadequate infrastructure and a shortage of skilled workforce. New methods can be implemented and ways of using solar energy in medium and large scale business can be designed. A novel idea would be to install medium to large scale solar plants to produce power and to commercialize it as the demand for electricity from alternative sources will be ever increasing.

KEYWORDS: Renewable energy sector, boost economy, efficiency, large scale business.

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1. INTRODUCTION

Solar energy directly or indirectly supplies most of the energy on Earth. Study about various methods to harness the solar energy has become an important area of research in recent times [1]. In developing countries, like India the energy crisis is alarming and the situation has to change. In spite of discoveries of oil and gas in various parts, the importance of crude oil continues to increase and so does the price paid for all other expenditure [2]. It is used in the form of solar water pumps, solar lamps, solar water heaters and cooking purpose. Solar energy can be tapped directly (by PV panels), or as biomass fuels. Solar energy gives least-cost options for economic and community development in various places across the globe. Solar projects in developing nations have resulted in positive change in the lives of many people bringing about electrification as well as employment.

2. FUNDAMENTALS OF PHOTOVOLTAICS

Photovoltaic systems (PV system) are widely used to convert incoming solar radiation into useful energy. Electricity can be generated from the solar energy using a process called the PV effect. The word "photo" refers to light and "voltaic" to voltage [3]. Solar panels are made with various sorts of semiconductor materials often coated by other additives or other substances which increase its productivity. The most widely used material for making solar PV is crystalline silicon. It is typically used in 90% of global commercial PV module production in its various forms. A typical silicon cell, having a radius of 2 in., can produce more than 1 W of direct current (DC) electrical power while receiving maximum solar radiation. These solar cells are connected in either series or parallel to get desired current and voltage. These groups of cells are packaged into packed modules that protect the cells from environmental and other factors and supply the desired current and voltage [4]. PV modules are extremely reliable because have no moving parts thus removing the chances for frictional and mechanical losses, which has an impact on efficiency and being in solid state always removes a lot of problems . The Silicon PV modules usually generated today have a life of over 30 years. A system is made up of one or more solar photovoltaic (PV) panels, a DC/AC power converter (also known as an inverter), a tracking system that holds the solar panels, electrical interconnections, and mounting for other components. The solar PV systems have proved to be beneficial and are used in various parts of India.

3. SOLAR POND

A solar pond is a pool of salt water which is used to collect and store solar thermal energy. The salt water forms a vertical salinity gradient also known as a "halocline", in which high-salinity water lies in the bottom layer and upper layers occupied by low salinity water. The salt solution layers increase in concentration (and density) with depth. After a certain depth, the solution has a uniformly high salinity. When solar insolation has contact with the bottom of a shallow pool, they heat the water at the lower levels. When water at the bottom the pool is heated, it becomes less dense than the cooler water above it, setting up convectional currents. Solar ponds heat water by impeding this convection. [5]

The lower layers are made completely saturated by

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repeated addition of salt thus increasing the salinity. High-salinity water at the lower levels of the pond does not mix readily with the low-salinity water above it, so when the lower layers are heated, convection occurs separately in the bottom and top layers, with only mild mixing between the two. This procedure prevents loss of heat and letting high salinity water to get up to 90 °C while the low salinity water stays at around 30°C . It is vital that the salt concentrations and cool temperature of the top layer are maintained in order for these ponds to work[6].This hot, salty water can then be used for power generation, through a turbine or can be used as a source of thermal energy.

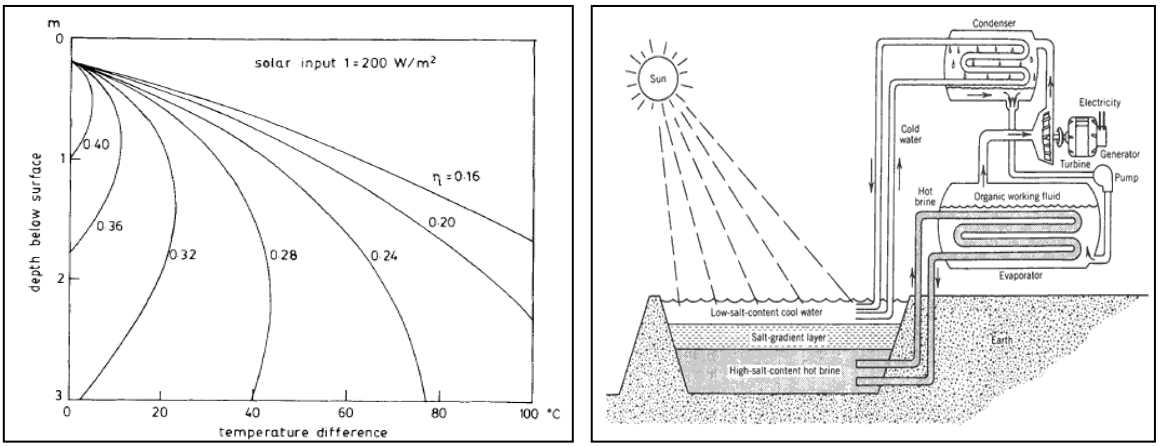


Figure 1Generation of electricity from solar ponds

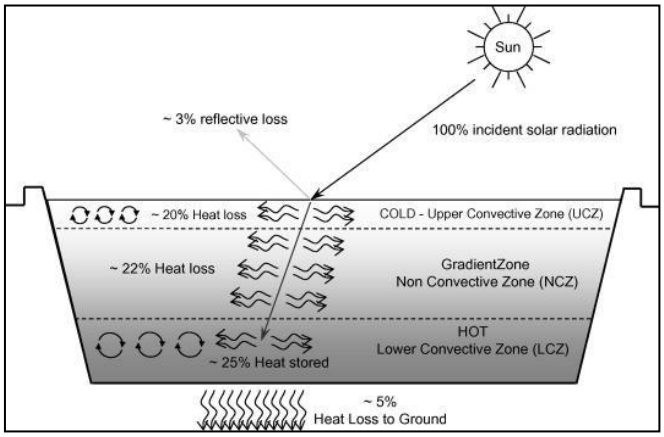


Figure 2 Layers in Solar Pond

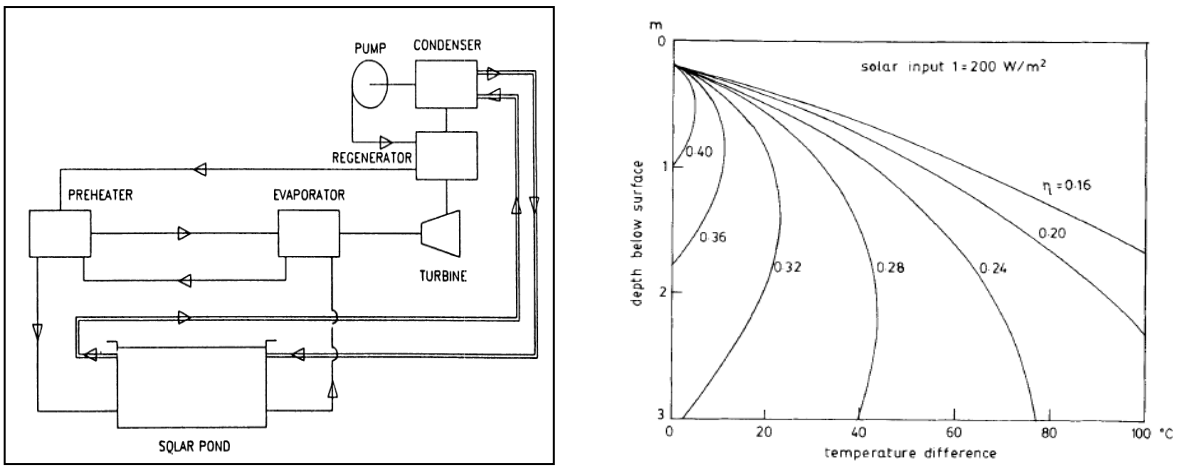


Figure 3 Power generation using solar pond

4. ECONOMIC VIABILITY OF SOLAR PONDS

There are a lot of issues regarding solar ponds,Solar ponds depend upon direct solar insulation, so setting up of solar ponds is viable in places with high incoming solar insulation, and lot of land free for use. Solar energy conversion devices are not in wide spread application because they require high initial capital investment [7]. The cost of a solar pond is a fraction compared to conventional flat plate collectors. The cost of a solar pond varies due to site-specific factors such as the local cost of excavation, cost of materials or labour .The thermal performance of a solar pond is also dependent on site-specific factors such as solar irradiation, ground thermal conductivity and water-table depth [8]. Hence, there is bound to be large variation in the cost of thermal energy produced by solar ponds at different sites in various parts of the globe.

It was estimated the cost of electricity obtained from a solar pond as follows,

$$C_E = \frac{C_R[C_p + C_{pp}G_e/N] + C_M}{G_e(1-f)},$$

Where Cr= cost of electricity, Rs/kWhe; C a = capital recovery factor; Cp =cost of solar pond, Rs/ m2; Cpp = cost of organic Rankine cycle power plant, Rs perk we; Ge= gross electricity genera-tion, kWhe/m2; N = number of hours of operation per year; Cm= maintenance cost, Rs/mZ; f= fractional parasitic losses.

Going by industry standards, we find that the cost of electricity obtained from a solar-pond power plant is higher than that obtained from fossil fuel-based thermal power plants but is comparable to the cost of electricity from diesel generation sets [9]. If the economic viability can be improved by taking into account certain measures, this source of power will be one of the sought after alternatives.

Ways to improve economic viability:

1. Selection of natural site for solar pond such as salt lakes, which don't require digging, lining or creating a salt environment.
2. Setting up of solar ponds in regions close to the equator or those which receive high solar insulation, thus increasing the value of N, i.e. number of hours of operation per year.
3. Setting up of solar ponds on a larger scale as with increasing area, the initial cost of the solar pond decreases.
4. Covering the solar ponds with surface membranes to prevent surface heat losses raises the temperature of LCZ to around 100 degree Celsius (as compared to usual 70 to 75) which now can be used for various industrial applications.

5. DEVELOPMENT OF SOLAR ENERGY IN INDIA

The need for power grows much faster for less developed nations than for those that already industrialized. Despite 30 years of major investment by less developed nations and organisations on electrification projects, nearly 2 billion people in developing regions around the globe still don't have access to electricity round the clock. Millions of people still rely on crude oil lamps and kerosene oil lamps for lighting. For such people staying in very remote areas, there is very low possibility of getting power from the electric grid. Off-grid solar power is a potential alternative to grid extension in rural electrification, which is costly and very inefficient and hard to manage [10].

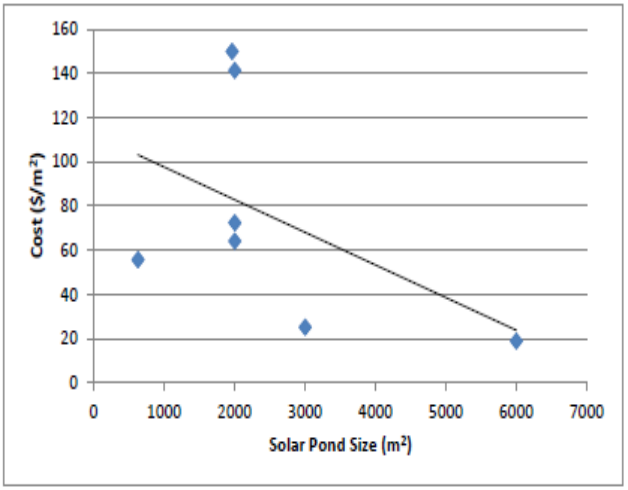
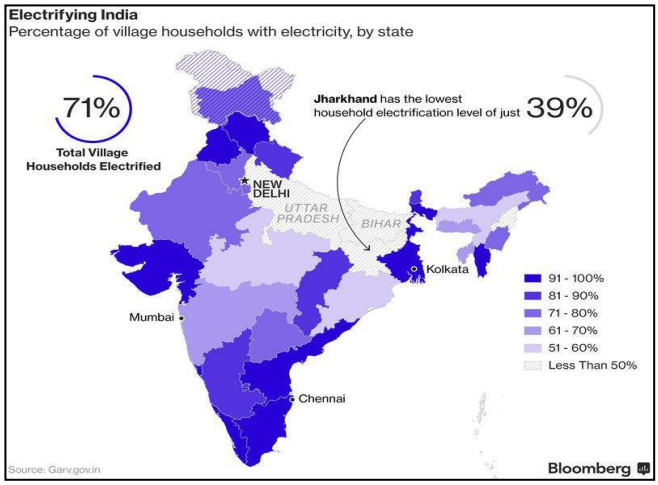


Figure 4 Cost of solar ponds per unit area vs solar pond size

Transmission line project	Length (circuit km)	Estimated cost (INR million)
INTERREGIONAL SYSTEMS		
Kahalgaon Stage-II (Phase-II) Transmission System (400 kV DC Ranchi-Sipat line)	816	5,498.2
Barh Thermal Project (3x660 MW) Transmission System (765 kV/400 kV DC lines)	2.447	37,794.6
North-West Transmission Corridor Strengthening Scheme (765 kV/400 kV DC lines)	600	4,831.0
East-West Transmission Corridor Strengthening Scheme (400 kV Ranchi-Rourkela-Raigarh-Raipur line)	1,230	8,037.0

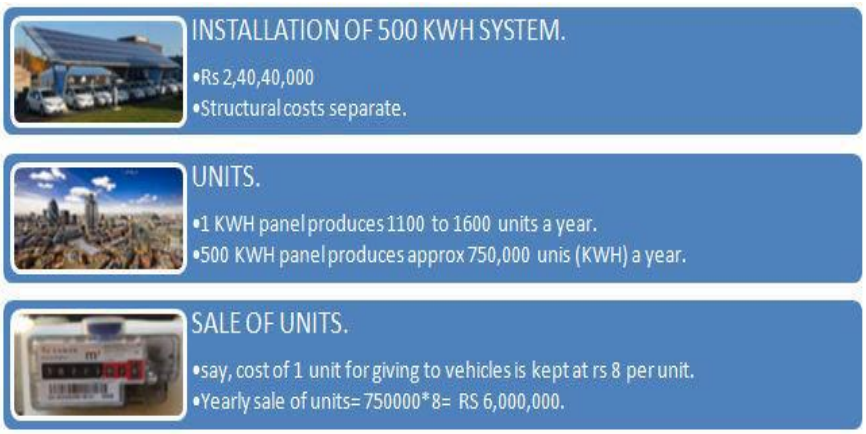


The expenses of bringing power via transmission and distribution lines to non electrified villages is too high and non viable if the villages are too far away from the power generation sources, Off grid systems are standalone systems and don't require any power supply to operate [11]. Generally, they have a battery or set of batteries connected to them where the power is stored. The power stored in the battery is used when the panels don't generate energy, for example during the night time. Thus it can be asserted that, off grid generation systems are the most viable option where power supply from the grid is not available.

Considering the fact that the cost of building transmission lines is excluded, off grid solar PV systems are the answer for rural India. The idea of installing off grid PV systems in rural areas also incorporates the idea of economic development in rural areas .PV provides electricity in remote areas for water pumping, refrigeration, and water treatment of community water supplies [12]. But there is a lot to be done to educate, institutionalize, and integrate renewable technologies so that everyone is benefitted from it. A great challenge is to work on reforming energy policies and legal frameworks that aids in the smooth and easy implementation of such systems in rural parts of India.

Table 1 Cost analysis of a household solar PV generation system of capacity 3Kwh

Equipment	Unit price	Total
12 x Solar PV	250W at R 3,500	R 42 000
Inverter 3K		R 15 000
4 x Battery	100AHr at R 3,500	R 14 000
Cables / Switches / cabinet		R 5 600
Mounting System	12 at R450	R 5 400
Installation cost		R5 500
		Total: approx. R90 000



As we talked about solar PV, a good idea would be to motivate people in domestic households to invest in off grid solar generation. Above, the cost analysis of a 3Kwh solar PV system is given; the system once installed will generate solar power for over 20 years with proper maintenance, thus saving on electricity bills.

6. COST PROPOSAL

Installation of solar generation cum charging point at a parking lot system will serve both the purposes of converting the parking lot into a EV charging station and also generation and consumption at the same point, basically implementing the idea of off grid solar energy generation.

The cost analysis is for a 500kwh system is given as follows.

Considering these calculations, and the fact that solar panels have a very long life of 20years and above, this business proposal is a good investment and also will cater the needs of electricity for solar cars. Staff will also be required, hence providing more employment.

7. CONCLUSION

Solar power is the ultimate source of energy. Measures should be taken to make utilizing and harnessing it cost effective and efficient. The government should take appropriate endeavour so that solar power is utilized as an alternative resource of energy which will benefit the country both economically and energetically.

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