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# PROSPECTS OF SOLAR POWER AND ITS APPLICATIONS IN BANGLADESH

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***Abstract-*** *Energy is not the ultimate demand of world but cost-effective and ecofriendly energy is the demand of world. But it is tough task to look for safe and cost effective power source. Today's world has marked solar energy as one of the prime source of energy which can help to fulfill the demand of energy as per demand if it can be used properly. Solar energy is used either in direct or indirect form as sun is the source of all kind of energy. Bangladesh being in the subtropical region solar energy is more suitable source than other power sources. In Bangladesh solar energy is not used in large scale but gradually use of solar energy is increasing. Reports says that Bangladesh's installed electric generation capacity was 10289 MW in January, 2014 out of which only 15 MW is generated by solar energy and used in rural households which is less than .01% of the total electricity generation. But Bangladesh receives an average daily solar radiation of 4-6.5 kWh/m$^2$. Now comes the point how and where this solar energy can be used. Solar power can be used in irrigation system, LED Street lighting across 5000kms streets, even in human driven rickshaws. Thus solar energy can be the best alternative of other power sources. Considering all facts of power production available new technologies and application of solar power with storage facility, probable capacity, cost per unit power, efficiency, suitability for Bangladesh discussed here in this paper so that solar energy can be considered as one major source of electricity of Bangladesh by applying new technology for the best use of solar energy in Bangladesh to eliminate energy crisis.*

**Key words:** Solar energy, Bangladesh, Electricity crisis

## 1. INTRODUCTION

In the face of tremendous social, economic and political pressure to solve power crisis in Bangladesh it has become critically important to look for energy solutions beyond the conventional sources likes gas, coal and imported fuels. Nuclear power is politically very sensitive and its initial cost is also high. Coal and gas reserves are continuously depleting and these are not environment friendly. Hydropower is good but Bangladesh doesn't have sufficient suitable water bodies to install hydro plant. Limited availability of organic wastes and vegetation restricts the widespread use of biomass energy. Global warming, increase in sea level and natural calamities due to excessive carbon emission from fossil fuel are causing havoc for low lying counties like Bangladesh. On the other hand the incident solar energy on the land of Bangladesh is more than enough for commercial solar power plants. Moreover the variation of sunlight intensity is less for at least six hours in Bangladesh. So, the most feasible way to out this multidimensional crisis is to increase use of renewable energy like solar power.

## 2. WHY SOLAR ENERGY IS PERFECT FOR BANGLADESH

Energy is inevitable part for the progress of a country like Bangladesh. Among all resources, solar energy can be considered as a safe source of electricity if production process is non-detrimental. Solar Energy is available everywhere; but the greatest amount is available between encircling the earth between 15" and 35" latitude north and south. Bangladesh is essentially suitable for solar energy as Bangladesh is situated between 20"43' north and 26"38' north latitude and as such Bangladesh is in a favorable position in respect of the utilization of solar energy. Annual amount of radiation varies from 1840 to 1575 kwh/m$^2$ which is 50-100% higher than in Europe. Taking an average solar radiation of 1900 kwh/m$^2$, total annual solar radiation in Bangladesh is equivalent to 1010 X $10^{18}$J. Present total yearly consumption of energy is about 700 X $10^{18}$J.This shows even if 0.7% of the incident radiation can be utilized; total requirement of energy in the country can be met. At present energy utilization in Bangladesh is about 0.15 watt/sq. meter land area, whereas the availability is above 208 watt/sq. meter. This shows the enormity of the potentiality of this source in this country [1]. Solar radiation varies from season to season in

Bangladesh. Bangladesh receives an average daily solar radiation of 4-6.5 kWh/m2. Monthly average solar radiation profile of Bangladesh is shown in the following figure1 [2].

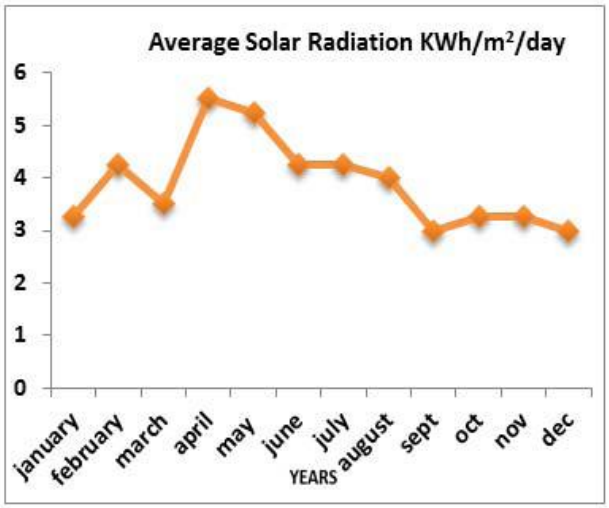


Fig.1: Monthly Average Solar radiation Profile in Bangladesh KWh/m$^2$/day

## 3. ADVANTAGES OF USING SOLAR POWER

Economic- Solar energy is best suited for Bangladesh for economic advantages as it is much cheaper than other power generating sector like nuclear power. It just needs some mechanical and technical assistance for generating power. New technological applications reduce cost to a great extent. Solar energy can provide electricity to coastal areas so easily.

Environmental- Considering environmental preservation issues, solar energy is really a good option if we consider other energy source like coal, oil, gas and nuclear power. Nuclear power plant can be dangerous for environment, as we observed the Fukushima (Japan) nuclear disaster, The Chernobyl disaster and others. Coal based power plants are harmful for environment. Recently Germany has decided to turn off all their nuclear power plant by the end of 2020. For a country like Bangladesh solar power is environment friendly and cost effective. Though solar power has some lacking but those can be eliminated by applying new technologies, plan and study.

Stability- Solar power is stable as it can last for a decade if proper precautions are taken. Technically it has a life span of 20 years.

Efficiency- Solar power is efficient for its power generating style. Solar cell is efficient up to 30%.

## 4. APPLICATION

### 4.1 Concentrated Solar Panel

CSP (Concentrating Solar Power): Concentrating Solar Power (CSP) is a promising technology for power generation in which the solar radiation i.e. direct normal irradiance (DNI) is concentrated to generate high temperature (400ºC to 1000ºC) for producing steam in a solar thermal power plant. This technology has been in use from the 1960's for large scale power generation as in solar power plants. This technology uses lenses or mirrors and tracking systems to focus a large area of sunlight onto a small area. The concentrated sunlight is focused onto either high efficiency photovoltaic chips or onto a heat transfer medium as in a conventional thermal power plant. The steam produced is in turn used to rotate a turbine coupled to an electric power generator. CSP systems work best at about 5.5kWh/m$^2$/day. Currently the cost of generating power using CSP technology is around 15 to 23 BDT per watt [3]. Some of the concentrating technology even offers storage facilities since normal operation at night time is not possible.

Bangladesh receives an average annual DNI of nearly 1,900kWh/m$^2$ which is sufficient to operate a CSP plant. Studies show that by the year 2015 the capital cost of CSP plant will become $3800/kWe [4]. As no fuel is required in CSP, this can be an attractive choice to minimize the power crisis of Bangladesh.

Based on the process of collecting and concentrating solar radiation, the CSP can be categorized into four major technologies: i) Parabolic Trough ii) Solar Tower or Central Receiver iii) Parabolic Dish and iv) Linear Fresnel Reflector (LFR).

**Case Study:**

The investment required to construct a 1MWe parabolic trough power plant is estimated in this paragraph. The estimation is National Solar Thermal Power Facility run by Parabolic trough technology in India in Gurgaon Latitude/Longitude Location: 28°25′ 39.0″ North, 77°9′ 33.0″ East. The location proposed is Cox Bazar with coordinates 21°35′0″N 92°01′0″E. The proposed area has been selected by the use of Google earth. It is situated on the bank of river Bakkhali. This area is selected because DNI (Direct Normal Irradiance) map of Bangladesh shows that it receives an almost constant DNI throughout the year which is shown in figure2 [5]. The electricity produced from this plant can be used to electrify some remote villages of Garjania union where electricity facility is still unavailable. The features of the proposed pilot project are shown in Table 1 along with that of the National Solar Thermal Power Facility project.

Table 1: Features of proposed pilot project [6]

| Criteria | National Solar Thermal Power Facility, India | Proposed project |
|---|---|---|
| Annual DNI | 600 kWh/m$^2$ | 1905 kWh/m$^2$ |
| Land area | 8000 m$^2$ | 14400 m$^2$ |
| Heat-Transfer Fluid Type | Therminol VP-1 | Synthetic oil (400ºC) |
| Thermal storage | Molten salt (60% NaNO3 and 40% KNO) | Molten salt (60% NaNO3 and 40% KNO) |
| Investment cost | $8 million | $3.8 million |
| Electricity Output | 1MWe | 1Mwe |

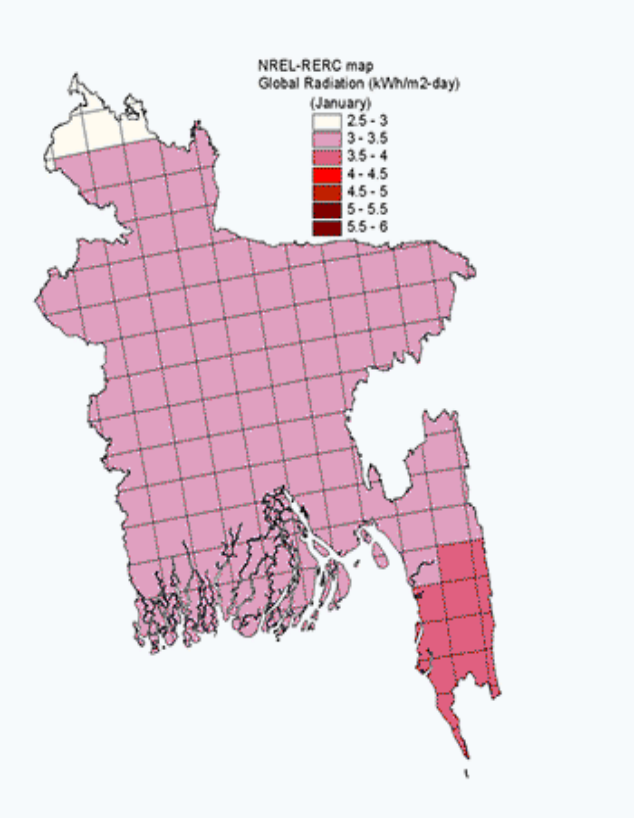


Fig.2: Solar radiation map (DNI) of Bangladesh

### 4.2 Solar Powered Vehicle

Solar energy can be too much beneficial for using in various types of smaller vehicles such as easy bikes, rickshaws etc. The solar panel used in the solar vehicle is of the rating of 140 WP. But, the solar panel rating should be changed according to requirement. Solar panel should be placed properly for achieving maximum sunshine. Multi crystalline cell is more preferable than mono crystalline cell as solar cell in the solar powered vehicles. The solar module mounted on the top of car is used to charge the batteries via charge controller. The output range of the 140 WP solar modules is 24V to 25V [7]. The batteries are initially fully charged and then they are connected to solar module for charging. This helps to keep the battery charged always. This is also done as the efficiency of solar module is only 15%.Thus under this condition the battery gets fully charged again within 3hrs-3.5hrs.This storage energy is used for running the vehicles. About 300 MW to 500 MW power is required for recharging Easy-bike in Bangladesh. This huge amount of electrical power can be saved through this technology.

At present, around two million or twenty lakhs people earn their livings by means of Rickshaw in the country [8]. 34% of the contribution of the transport sector to the GDP of Bangladesh comes from the Rickshaw sector [9]. Rickshaws which are available in our country are manual pedaling type & electric motorized type. The Government of Bangladesh banned import and assembly of an Electric Motorized Rickshaws because the Rickshaws are consuming 300 MW power per day from the national grid [10]. Solar powered rickshaws can be introduced for saving this power. The price Solar Powered Rickshaw is about BDT 80000 (1 USD = 79 Taka). A Rickshaw puller can nearly earn BDT 1,000 in a day [11].

As solar vehicles (Easy bikes, Rickshaws) are eco-friendly & can be manufactured with ease solar energy should be used for preserving the non-renewable sources of energy.


Fig.3: Solar Powered Vehicle

### 4.3 Solar LED Street light

Solar energy can be applied for another important application in street lighting. There are 11 City Corporations in the country where lies approx. 5000 km streets. Actually, the lights used conventionally are not efficient enough. Besides, these require more electrical power. Solar PV LED (light emitting diode) Street lighting system can reduce pressure on conventional power use. In this lighting system, Solar Panel size would be 100 Wp, 75 Wp and 40 Wp respectively. It should be mounted properly for receiving maximum sunlight. Lead acid battery is charged by using solar energy as the source during day time. The system would require the use of a microcontroller to control many of the circuit functionalities including Switching, controlling driver circuit, and integrating sensor output etc. Since DC supply is being used, a DC-to-AC converter is employed to implement the LED. According to ADB's preliminary study, 40 W, 30 W and 15 W LED Lighting System could be used. LED lighting offers high efficiency, long operating life and low voltage operation which ideal for solar. Thirty three LED units might be required to electrify 1 km street [12]. This street lighting system can keep contribution by minimizing electricity use from power grid. System circuit diagram for solar street lighting is shown in figure 4 [13].

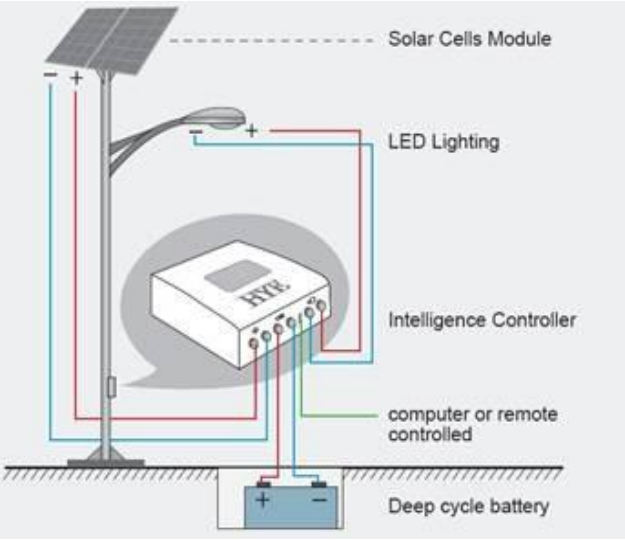


Fig.4: Solar Street Light

### 4.4 Installation of Solar Irrigation System

As an agricultural country, irrigation is so much important for Bangladesh. 98% of 11 million hectares area under rice production requires irrigation. About 336000 pumps are used during dry seasons for irrigation purpose [14]. In Bangladesh, many villages are in the off-grid condition. About 50% [15] people living in this country are off-grid. So, most of the irrigation is performed with diesel generators. There are about 1.2 Million diesel operated pumps requiring 800 Million liters imported diesel per year. As, the price of petroleum is increasing across the globe, this irrigation system is so expensive for farmers. So, it is important to explore alternative energy sources for irrigation to ensure both food and energy security. In this context, the application of solar irrigation pump has tremendous potential especially to decrease the dependence on diesel, an expensive liquid fuel.

Solar Powered Irrigation System:

In this irrigation system, highly sophisticated materials are not required. Solar panel & solar submersible pumps are main parts of this system. Solar panel is for producing electrical energy with the proper utilization of sunshine. This produced energy is used for running the pumps which leads to irrigation. But, this energy is small scale energy. A viable alternative is micro-grid system where standalone small size grids are designed to provide power to small rural areas from a centrally located power station. These power stations could be solely solar PV or solar PV-Diesel hybrid [16]. Under the proposed program, a total of 10,000 solar irrigation pumps can be installed all over the country to replace diesel based pumps. The pump of 8 kW size is capable to lift 500,000 liters of water per day in local solar irradiation condition i.e. 4.5 kWh/m2/day [12]. This irrigation technology could reduce cost of irrigation as well as could save foreign currency.

Fig.5: Solar Irrigation Pump

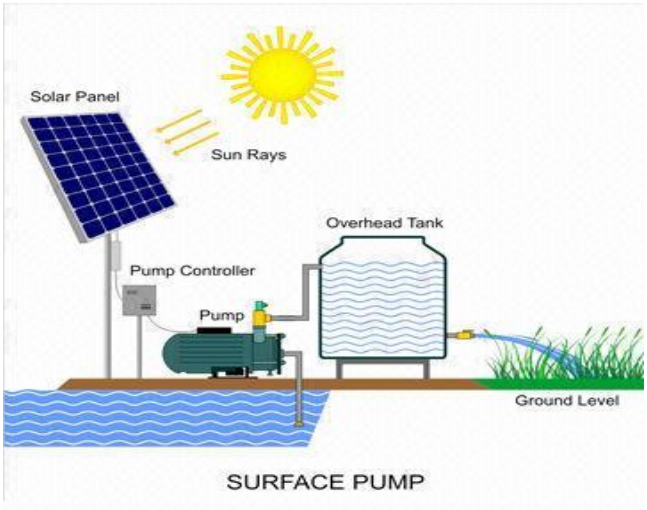


Fig.6: Solar Irrigation System

## 5. CONCLUSION

Considering all the ways of power generation, Bangladesh should look forward on solar power as future of power generation. For a poor country like Bangladesh it is really necessary to concentrate on solar power due to huge availability of resources and cost effectiveness rather than other ways of power generations which are also hazardous for environment. With the progress of development, demand of power is increasing. To meet up this demand solar power must be considered as a main source. With application of new technologies power generation can be possible with low rate and more easily. Proper use of solar power resources can be assured easily. Application of solar power in the fields discussed here shows that people will not have to depend upon the national grid only but they can also use solar power for various purposes to improve their lifestyle. Bangladesh may appear as role model for using solar power properly to fulfill its demand of electricity.

## 6. ACKOWLEDGEMENT

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