

## A Solar System to reduce the Power Crisis in Bangladesh through Electric Vehicle Recharging Station

Sikder Sunbeam Islam<sup>1</sup>, Md. Jashim Uddin<sup>2</sup>

<sup>1</sup>(Lecturer, Department of EEE, International Islamic University Chittagong, Bangladesh)

<sup>2</sup>(Lecturer, Department of EEE, International Islamic University Chittagong, Bangladesh)

**Abstract:** Renewable energy resources can play an important role in a developing country like Bangladesh. In Bangladesh the electric vehicles powered by rechargeable batteries are becoming popular day by day. But it is a matter of great regret that a big amount of power is being used daily to recharge their batteries at the recharging stations. As Bangladesh faces acute power crisis this is a big challenge. This paper has proposed a PV based recharging station for electric vehicles and made a detail analysis on it.

**Keywords:** Solar System, Recharging Station, Power System.

### I. Introduction

An enormous amount of energy is extracted, distributed, converted and consumed daily in the present world. The energy demand in the whole world is increasing day by day. Today's global energy production is high, in fact 83% [1]. At present the power demand in Bangladesh is about 6500 MW which was 6000 MW in the last year (2011) and the generation capacity is around 5000MW but peak demand is estimated to exceed 5,000 MW [2]. Moreover, our average growth demand is around 7% which indicates that if we do not add 10% every year we going to face a big electricity crisis problem in the near future [13].

Monthly global solar insolation and daily average bright sunshine hour in Dhaka city are presented in Figure 1.1 and 1.2 respectively [3].

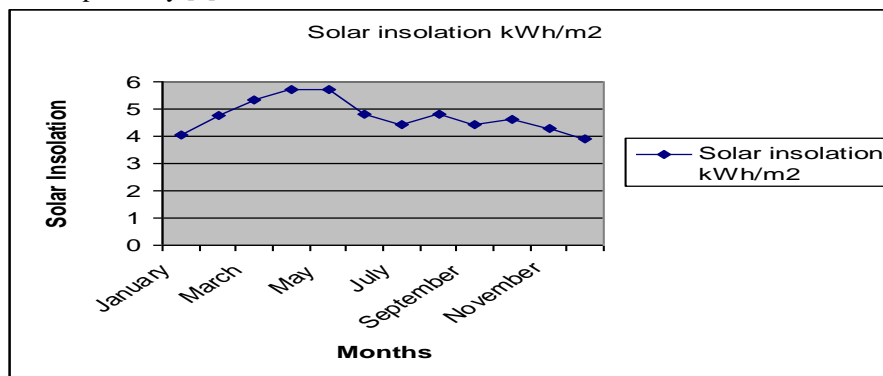


Figure 1.1: Monthly solar insolation at Dhaka

From the Fig 1.1, it is found that the average solar insolation is 4.73 for Dhaka and from Fig 1.2 , the daily average bright sunshine is 7.55 hours for Dhaka. The solar resource is abundant in Bangladesh as the tropic of cancer passes closely through the geographical centre of Bangladesh. So, the average Global Horizontal Irradiance is 625 W/m<sup>2</sup> [4].

$Irradiance = (Average\ Insolation) / \square \square Average\ daily\ bright\ sunshine\ hours,$

For our system we have to consider Solar insolation = 4.7 kWh/m<sup>2</sup>

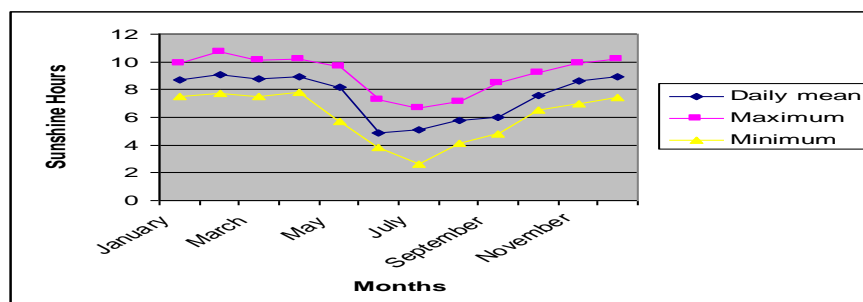


Figure 1.2: Daily average bright sunshine hours at Dhaka City

Electric Vehicles also known as Easy Bikes [5] in Bangladesh are rechargeable battery based energy efficient and environment friendly popular vehicles. As it is rechargeable battery based there is needed a lot of power every day. As a result the power crisis is increased. But there is a lot of fuel recharging stations in Bangladesh where there is a great opportunity to implement solar based recharging station.

For designing and cost analysis data are collected from local and international markets and the electricity production's data is calculated manually with respect to Dhaka city.

## II. Electric Vehicle

Electric vehicles (EVs) are propelled by an electric motor (or motors) which are powered by rechargeable battery packs [6]. Electric motors have several advantages over internal combustion engines (ICEs) [6]:

- It is 55% more energy efficient than typical internal combustion engines (ICEs) based vehicles.
- It is more environment friendly than typical internal combustion engines (ICEs) based vehicles.
- It provides stronger acceleration and smooth operation than that of ICE based vehicles.
- It needs comparatively less Maintenance and it is easier.



Figure 2.1 An electric vehicle in Dhaka City [5]

## III. Design Of Pv System

### 3.1 Location

Dhaka is the capital of Bangladesh. Dhaka's geographical coordinates are 23° 43' 23" North, 90° 24' 31" East [7].

### 3.2 Module Accommodation on Roof Area

The PV modules are accommodated on the roof of fuel filling stations. Generally the roof is plain as a result there is no problem to set up but for maximum efficiency the PV modules are tilted with an angle which depends on the location of the installation. The PV module is accommodated on roof area of the fuel filling station like Fig 3.1.



Figure 3.1: A general fuel filling station

For this system let us consider the length of the roof is around 80 feet and the breadth is around 40 feet. The layout is given in figure 3.2. The number of components is calculated with the help of this consideration.

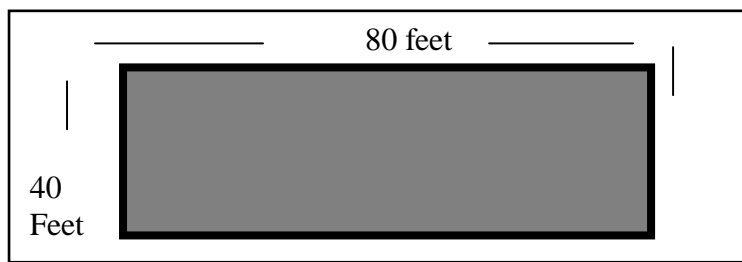


Figure 3.2: The considered layout

### 3.3 System Design

As a solar based system the system can be designed with some PV modules, Charge Controller boxes, control circuit etc in the system and the representation of block diagram is given in Figure 3.3.

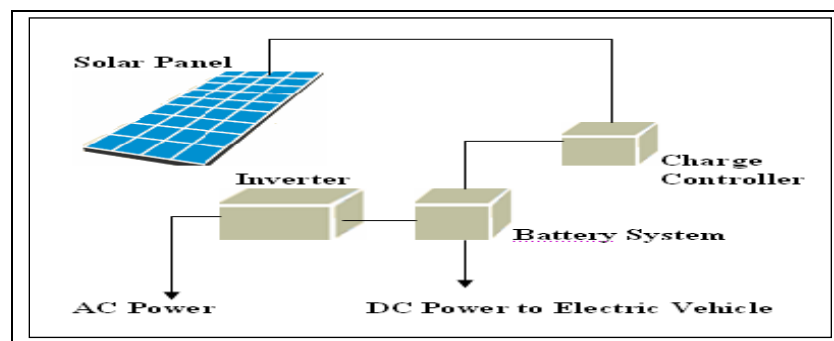


Figure 3.3: Total block diagram for the System

### 3.4 Cost Analysis

#### 3.4.1. Solar Energy

Our estimated system capacity is 8 KW/ day and our daily average bright sunshine is 7.55 hours for Dhaka. So, total energy per day is  $(8 \times 7.55) = 60.4$  KWh/day. Considering overall efficiency 55% total input power =  $8 / 0.55 = 14.55$  KW. If we choose 230W solar panel each, the number of solar panels will be =  $(14.55 \times 1000) / 230 = 63.24 \approx 63$ .

#### 3.4.2. Battery Bank Calculation

Suppose, the voltage rating of the battery for the battery bank = 12 Volt.

Capacity of each battery = 120 Amp-hour.

So, energy stored in each battery =  $120 \times 12 = 1440 = 1.44$  KWh

Maximum KWh needed/day (in December) = 71.2 KWh ; see Figure-5.1

The rest energy per day is needed to be stored =  $(71.2 - 60.4)$  KWh = 10.8 KWh.

So, number of battery needed =  $10.8 / 1.44 = 7.5 \approx 8$  batteries.

The different essential components with respective quantity and costs are given in Table 4.1.

Table 4.1: Cost components of our proposed system.

Component	Description	Qty	Cost in Taka <sup>#</sup>
PV module	Sharp NU-U235F1 [8]	63 (Calculated)	$63 \times 46,000 = 28,98,000$
Inverter	3000VA inverter [10]	7 (Calculated)	$28,000 \times 7 = 1,96,000$
Charge controller	Local market	1	1,000
Wiring	Approximate		5,000
Battery	12 Volt	8	$10,000 \times 8 = 80,000$
Control circuit, installation, maintenance and others	Approximate		20,000
Total			32,00,000

#80 taka=1 US dollar (appx)

#### IV. Daily And Monthly Electricity Generation

In our proposed system the estimated capacity is around 8 KW. So to find out the daily energy generation we have to multiply this number to monthly average sunshine duration and the maximum 71.2 KWh/day is found in December. Again for finding the monthly energy generation we have to multiply daily energy generation to number of days of each month respectively. The calculated data is shown in fig 5.1.

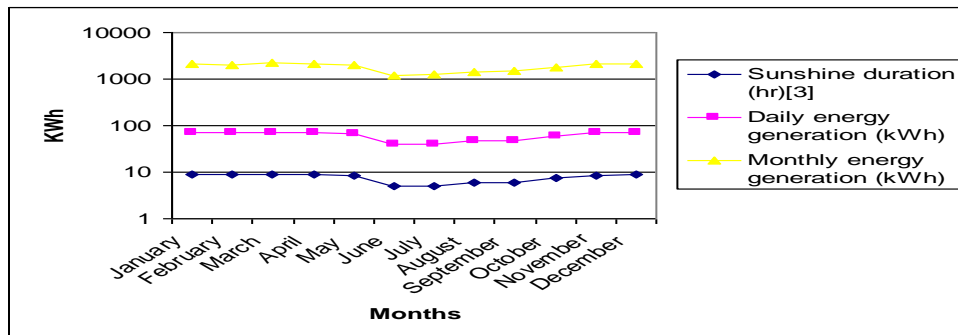


Figure 5.1: Daily and monthly average electricity generation in kWh

#### V. Monthly Income

From the above fig 5.1 we can find the monthly energy generation. From monthly energy generation we can calculate the monthly income and the summation of monthly income is referred to annual income which helps us to find payback time of our proposed system. In figure the monthly incomes are shown which is calculated in different consideration and the considerations are per kilowatt hour equal to 6, 8 and 10 respectively.

Table 6.1: monthly and yearly income of our proposed system

Month	Monthly energy generation (kWh)	Income in Taka ( 1 kWh= 6 taka)	Income in Taka ( 1 kWh= 8 taka)	Income in Taka ( 1 kWh= 10 taka)
January	2,157.6	12,945.6	17,260.8	21,576
February	2,038.4	12,230.4	16307.2	20,384
March	2,182.4	13,094.4	17459.2	21,824
April	2,136	12,816	17088	21,360
May	2,033.6	12,201.6	16268.8	20,336
June	1,176	7,056	9408	11,760
July	1,264.8	7,588.8	10118.4	12,648
August	1,438.4	8630.4	11507.2	14,384
September	1,488	8,928	11904	14,880
October	1,824	10,944	14592	18,240
November	2,132.8	12,796.8	17062.4	21,328
December	2,136	12,816	17088	21,360
Total ( Yearly Incomes)		132,048	176,064	220,080

#### VI. Payback Time Analysis

The payback time means that the number of years required for the improvement to pay for itself and for cost benefit analysis of our proposed system it is needed.

$$\text{Simple payback time} = (\text{Cost of the system}) / (\text{Annual savings}), \text{ years}$$

**Considering 1kWh= 6 taka:**

Cost of the system = 32, 00, 000 taka

Annual income = 132,048 taka

Payback time (year) = (Cost of the system / Annual income) = 32, 00, 000/ 132,048= 24.23 year

**Considering 1kWh= 8 taka:**

Cost of the system = 32, 00, 000 taka

Annual income = 176,064 taka

Payback time (year) = (Cost of the system / Annual income) = 32,00,000/ 176,064 = 18.18 year

**Considering 1kWh= 10 taka:**

Cost of the system = 32,00,000 taka

Annual income = 220080 taka

Payback time (year) = (Cost of the system / Annual income) = 32,00,000/ 220,080 = 14.54 year

## **VII. Opportunities, Benefits And Challenges**

### **7.1 Opportunities and Benefits:**

The opportunities and benefits are given below:

1. The existing fuel stations can be used. No other site is needed to be selected. 2. The payback time is estimated and lesser than other system. 3. No extra labour cost and maintenance cost is needed. 4. Extra power can be used for the recharging station itself 5. This system becomes one of the factors to increase the income of the owners of fuel filling stations. 6. Proper utilization of solar energy. 7. Dependence on fossil fuels such as Diesel, Petrol and Gas etc is decreased. 8. It is a pollution free process.

### **7.2 Challenges and Limitations:**

The challenges and limitations are given below:

1. Initial cost is high for the owner of the fuel filling stations. 2. The design must be perfect. 3. Lack of knowledge about proper maintenance of Solar based technologies. 4. During night and insufficient solar radiation the system is not work properly. 5. For fully recharging the battery pack can take 4 to 8 hours. Even a "quick charge" to 80% capacity can take 30 min [6].

## **VIII. Conclusion**

Although the Electric vehicle has some limitations, its environment friendly nature has made it popular to all over the world. So, it is clear that our proposed system could be an effective one due to its necessity in the power crisis context. Though our proposed system is designed for Dhaka city and costs are calculated with respect to Dhaka city, this system is implemented anywhere in Bangladesh. And it is also said that this proposed system is economically and geographically feasible to Bangladesh.

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