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Use of Solar PV and Hybrid System in IUT Library – A Case Study

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ABSTRACT: The need and importance of use of energy-particularly electricity at increasingly higher quantities and rates can hardly be overemphasized in order to accelerate the growth of socioeconomic development. Electricity is mostly, generated in power plant by burning conventional fuels: coal, oil, gas, biomass or using hydro potential or in the nuclear power plant through nuclear fission. The conventional sources are finite and their prices fluctuate. The sources pollute environment and cause global warming up. Renewable and environment friendly energy sources like: solar PV, wind, tide etc. therefore, drawing attentions of the technologists and the policy makers to meet ever-increasing demand of electricity and at the same the keep the consequent environment degradation to an acceptable level. Among all the renewable sources solar is more appropriate for Bangladesh especially solar photovoltaic (PV) due to her position in the tropical region. To make the electricity supply of IUT more efficient solar PV can be a useful source. So IUT library had been chosen as a case study. Solar photovoltaic along with grid supply can be combined to generate a hybrid system which will produce optimum energy mix.

Keywords: Solar PV, Conventional fuels, Hybrid system, IUT, Economical analysis.

I. INTRODUCTION

Renewable energy is a term used to describe energy that is derived from naturally occurring resources such as sunlight, wind, tides, rain, and geothermal heat that are continually available to some degree or other all over the world. These sources of energy never run out as it continuously renews itself in a small time period, unlike the conventional energy sources such as oil, coal, natural gas etc. The source is not dependent on the rate of consumption. These types of energies are environmentally friendlier and termed as "Green Energy". Usage of these types of energies supports sustainable development by reducing carbon emissions. This contributes to increasing energy and climate security for many communities across the world. Future years, beginning about 2020, may also see the introduction of building-integrated PV elements (e.g., PV shingles, etc.) that have much improved aesthetics and may further reduce net system costs by replacing other roofing materials [1, 2]. Future years might also see the introduction of thin-film PV technologies [3].

Solar photovoltaic modules are solid-state semiconductor devices with no moving parts that convert sunlight into direct-current electricity. Therefore, a solar PV panel module when exposed to sunlight generates voltage and current at its output terminal. This voltage and current can be used for our electricity requirements. The amount of electricity a solar PV module can generate depends on the amount of sunlight available to it and also on the size of the module. To get practical idea of using solar photovoltaic the conversion or use of hybrid solar PV systems in the IUT library has been studied. The economic analyses of such a hybrid system have been made and resented in this paper. The paper will also reflect the solar photovoltaic energy status and development trend from global perspective as well as the cost benefit analyses of a hypothetical system of IUT.

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II. SITE CHARACTERISTICS

In IUT Electrical System presently there are two sources used for providing electricity

- Rural Electrification Board (REB) supply
- Generator supply

This paper not only **r**reflects the importance of solar photovoltaic energy but also studies the economic analyses of a hybrid system in IUT library. The measuring cost benefit analyses of a hypothetical system of IUT have also been analyzed in it.

TABLE IPOWER FAILURE DATA OF IUT FROM NOV 2009 TO SEP 2010 [*4*]

Month	No. of times power	Total Hours lost	Total fuel consumption
November 2009	10	15	1200
December 2009	38	59	1600
January 2010	40	62	2800
February 2010	57	87	3200
March 2010	113	168	9200
April 2010	128	190	11600
May 2010	91	138	7200
June 2010	101	153	9600
July 2010	121	183	10200
August 2010	139	207	15200
September 2010	86	127	6700
Grand Total for 11 months	924	1389	78500
Monthly Average	84	127	7100

Our case study would help us to know the importance of solar PV system as an alternate electricity source. IUT library was classified into the following sections with their different working hours.

TABLE II. OPERATION HOUR OF DIFFERENT SECTION OF LIBRARY

Section Name	Working Period	Total Working Hour
Stain Case Section	8a.m.-10p.m.	14
Student Study Centre	8a.m.-10p.m.	14
Reference Section	8a.m.-1p.m. & 2p.m.-5p.m.	8
Book Section	8a.m.-1p.m. & 2p.m.-10p.m.	13
Photocopy and Lobby section	8a.m.-1p.m. & 2p.m.-5p.m.	8
Varanda Section	8a.m.-1p.m. & 2p.m.-10p.m.	13
Toilet Section	8a.m.-10p.m.	14

TABLE III. CALCULATION OF TOTAL DESIGNED AND CONNECTED LOAD OF IUT LIBRARY

Designed Load		Actual Load	
Load Name	Amount	Load Name	Amount
Tube lights (36 W)	266	Tube lights (36 W)	205
Fans (80 W)	42	Fans (80 W)	40

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Bulbs (60W)	10	Bulbs (60W)	10
Tube lights (20W)	05	Tube lights(20W)	05

Total Designed Load = 266*36W+42*80W+10*60W+5*20W = 13.636 KW
Total Actual Load = 205*36W+40*80W+10*60W+10*60W+5*20W = 11.28KW

III. RESULTS AND DISCUSSION

Economic Analysiswas completed considering the following three different situations

- Total cost consumption with Grid Supply at present loads
- Total cost consumption with Solar PV with modification at load capacity
- Total cost consumption with a Hybrid system

Total supply from Grid Supply with 36W Tube lights and 80W Fans

Total energy consumption = [(104*36+29*80)*2+ (114*36+30*80)*2+(103*36+27*80)*2+ (115*36+26*80)*2+(100*36+29*80)*2+(66*36+20*80)*2+ (65*36+20*80)*2] /1000 KWh =76.984 KWh (daily)
Total monthly energy consumption =76.984*30=2309.52KWh
Monthly charge=2309.52KWh*4.63BDT/KWh =10693.07 BDT
Service charge = 65 BDT
Capacity charge =259 BDT. (2.43% of total charge)
Net bill = (10693.07+65+259) =11017.07 BDT
Vat = 551 BDT (5% of Net bill)
So for one year we get = (11017.07+551)*12=138816.84
For 30 years = 138816.84*30 = 4164505.2 BDT = 4.1645 million BDT

Total supply from PV replacing 36W Tube Lights with 18W Fluorescent Lamps

Total energy consumption=52.972KWh (following the same calculation procedure)
Panel rating = 1200Wp
energy produced by one 1200Wp panel in a day =(1200*0.72*0.75*8)/1000=5.184KWh (combined efficiency=0.72,operating factor = 0.75)
So No. of PV panel required =52.972/5.184=10.218=11 (round)
Cost of panels=11*1200Wp*135BDT/ Wp *1.3=23, 16,600BDT
Battery required = ((66*18+20*80)*2+(65*18+20*80)*2)/ (0.72*12)=1287Ah*1.3
=1673.1Ah/130Ah=12.87=13 (round) [safety factor =1.3]
Total cost of battery=13*14800*6 = 11, 54,400BDT
Inverter required =115*18+30*80 = 4470VA
So cost of the inverter =6,00000BDT [Source: Pacific solar limited]
With 3yr of life time total cost =60,000*10=730000BDT
Cost of charge controller =1000*10*1.3=13000BDT
Total cost of generation = 2316600+1154400+6,00000+13,000 = 4.084 million BDT

So we get Cost with Grid Supply is **4.164** million BDT and with PV is **4.084** million BDT

We will do the same calculation for a Hybrid system. The combination of PV and grid system will be demonstrated.

Total Supply from a Hybrid system, PV for Light Loads and Grid for Fan Loads
With analysis for 15 days we have got energy consumption only for lights=25,000KWh

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No. of panel required =25000/5184=4.82=5(round)
Cost of panel =5*1200*135*1.3=10,53000BDT
No. of battery required = [((66*18)*2+ (65*18)*2)/ (.72*12)]*1.3=709.6/130=5.82=6(round)
Cost of battery = 6*14800*6=5,32,800
Cost of inverter=450000BDTFor (115*18*1.3*10=2691VA)
Cost of charge controller =1000*1.3*10=13000
So total cost =1053000+532000+450000+13000=20,48000BDT
From grid total energy consumed=28.90KWh (daily)
So monthly cost =28.96*30*4.63=4022.544Tk
Service charge =65BDTand capacity charge =97 BDT
So total cost = (4022.544+65+97) +209(5% vat) = 4393.44TK
For 30 years we get =4393.44*30*12=1581638.4 BDT
The total combined cost =2048000+1581638.4 = 3.6296 million BDT

IV. RECOMMENDATION

One of the major observations is 18W LED should be used instead of 36W florescent Tube light in the Library to reduce the electricity loss. Similarly the use of motion sensor device will also prevent the wastage. The hybrid System can be implemented for IUT Library but there should be one prerequisite such as solar PV should be used only for light loads. The system voltage can be increased by connecting batteries parallel, thus making the system stable. The case study was done only on the IUT library, and the same can be done for IUT cafeteria, Mosque and Medical Center.

V. CONCLUSION

In our case study we tried to have an idea about the global growth trend and suitability of use of Solar PV in Bangladesh. The Case study on the IUT library gave us a practical idea of using solar photovoltaic and use of a hybrid solar PV system. For very high load demand the use of PV is not justified as the cost sums up to be very high and should only be used for smaller load. It is also a good idea to use PV in rural areas instead of extending the grid line. In the future if the cost of PV components becomes less and the efficiency of the panel is increased, we can use it in large scale as well.

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