Study of 12KW Solar Office System at Atomic Energy Centre Chittagong

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Abstract— *In this article, A Study of 12KW Solar Office System (SOS) at Atomic Energy Centre Chittagong (AECC) has been presented. The SOS has total of 12KW install capacity (panels) with 220V AC, 50 Hz, Single phase (off-grid) power supply consists of forty eight Solar Panels (250W, 30V, 6.25A), three Solar Charge Controllers with MPPT (48V, 60A), three Inverters (5000VA, 48V), a Battery Bank of 1531AH total twenty four batteries (12V, 130AH) and required accessories (mounting structures, cables and clamps, solar breakers, output breakers, energy meters etc.). This study has been completed according to notification of award for supply, installation, testing and commissioning of solar energy setup under establishment of atomic energy centre project at sholashoar, East Nasirabad, Chittagong.*

Keywords— Solar Cell/Panel, Solar MPPT, Solar Inverter, Battery Bank and Solar System.

I. INTRODUCTION

Photovoltaic (PV) power generation systems are received more and more attention in recent years. According to the latest report of IEA-PVPS on installed PV power by the end of 2010[1]. In this context, the applications of concentrator PV system in water pumping practically consists of PV, controller, battery and inverter, two types of small pumps were utilized. One 220 V, 10 W AC and 12 V, 12 W DC water pumps were procured to evaluate their performances using the generated power from locally developed a concentrator PV system [2]. Design, analysis and performance study of a hybrid pv-diesel-wind system for a village Gopal Nagar in Comilla used 1KW pv array in their simulator[3].In the current research, Solar Office System (SOS) 12KW install capacity (panels) with 220V AC, 50 Hz, single phase (off-grid) power supply has been presented.

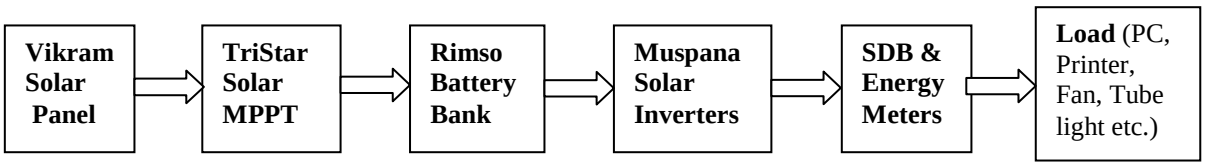

Fig.1: Block Shows the Configuration of the Installed 12KW Solar Office System.

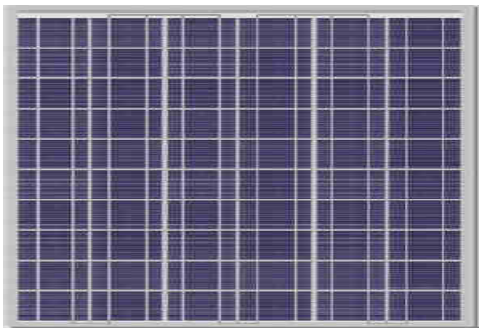

Fig.2: Vikram Solar Panel (250W, 30V, 6.25A)

Fig.3: TriStar MPPT Solar Controller (48V, 60A).

Fig.4: Rimso Solar Battery (12V, 130AH).

Fig.5: Muspana Solar Inverters (5000VA, 48V).

II. METHODOLOGY

2.1: Vikram Solar Panels

A solar cell is a device that converts light energy into electrical energy. Sometimes, the the term solar cell is reserved for devices intended specially to capture energy from sunlight while the term photovoltaic cell is used when the light source is unspecified[4].

Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating. A photovoltaic (in short PV) module is a packaged, connected assembly of typically 6×10 solar cells. Solar Photovoltaic panels constitute the solar array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions, and typically ranges from 100 to 365 watts. [5].

Location at the Roof of the AECC building .Name: Vikram Solar, Country of Origin:India

Manufacturer: Vikram Solar Pvt. Ltd. Features of Eldora - 250P are designed for high area efficiency ideally suited for roof top and ground mounted applications, Guaranteed (0 to +4.99)Wp positive power output tolerance ensuring high return on investment, Extremely reliable product suiting all environmental conditions, Engineered to provide excellent low light response.

Table.1: Shows the Electrical Data - All data refers to STC (AM 1.5, 1000W/m^2, 25^{0}C).

Type	
Nominal Power, Pmpp (0~+4.99Wp)	250
Nominal Voltage, Vmpp(V)	30.58
Nominal Current, Impp(A)	8.18
Open Circuit Voltage ,Voc(V)	37.55
Short Circuit Current, Isc(A)	8.71
Module Effiency (%)	15.53

Electrical Parameters' tolerance ±3% except Pmpp. NOCT: irradiance 800W/m^2, ambient temperature 20^{0}C, wind speed 1m/s [6].

2.2: TriStar MPPT Solar Controller

Maximum power point tracking (MPPT) is a widely used control technique to extract maximum power available from the solar cells in a photovoltaic system. The maximum power generated by the PV panel changes with the intensity of the solar radiation and the operating temperature. To increase the ratio output power/cost of the installation it is important that PV panel operates in the maximum output power point (MPPT) [7].

Morningstar's TriStar MPPT solar controller with TrakStar Technology is an advanced maximum power point tracking (MPPT) battery charger for off-grid photovoltaic (PV) systems up to 3kW. The controller provides the industry's highest peak efficiency of 99% and significantly less power loss compared to other MPPT controllers.

The TriStar MPPT features a smart tracking algorithm that maximizes the energy harvest from the PV by rapidly finding the solar array peak power point with extremely fast sweeping of the entire I-V curve.

Location: Room no. 105 (Ground floor) of AECC building 48V, 60A.

Name: Tristar MPPT

Designed in USA made in Taiwan

Manufacturer: Morning Star

Model: TS-MPPT-60

Table2: Shows the Technical Specifications (Electrical) of Solar Controller MPPT.

Type	TS-MPPT-60	
Maximum Battery Current	60 amps	
Nominal Maximum Solar Input	12 Volt	800 Watts
	24 Volt	1600 Watts
	48 Volt	3200 Watts

Technical Specifications (Electrical) of Solar Controller MPPT has been mentioned above[8].

2.3: Rimso Solar Battery Bank

Long life, high performance, low maintenance Rimso solar battery has positive tabular plate, negative plate, separator, container, cover, ceramic vent plugs, heavy duty terminals and electrolyte[9].

Battery Bank of 1531AH has total twenty four 12V 130AH lead acid batteries. Location: Room no. 105 (ground floor) of AECC building.

Name: Rimso Battery, Country of Origin: Bangladesh**,** Manufacturer: Rimso Battery & Co.

Model: 6RBT -200A , ISO: 9001 – 2008, ISO :14001 – 2004.

2.4: Muspana Solar Inverter

Inverter, DC-AC is very essential for most of the precise and sophisticated instruments and electrical and electronic systems to prevent a shutdown or damage or operation in case of power failure. Therefore, the most diffused application of power electronic devices is to invert the DC generated from some dispersed energy resources (e.g., photovoltaic, fuel cells, micro turbines and battery storages) to existing 50/60 Hz AC [10].

Location: Room no. 105 (ground floor) of AECC building.

Name: Solar Inverter

Made in Bangladesh

Manufacturer: Muspana

Muspana solar inverters are pure sine wave inverters for off-grid applications requiring AC power. Applications included rural electrification, telecom, remote homes, caravans and boats. Pure sine wave provides quality AC equivalent to grid power.

Technical Specifications		
Input		
Power	500W 750W 1KW 1.5KW	2KW 3KW 4KW 5KW 6KW 8KW 10KW
DC voltage	12-24 V	48-96 V
Output voltage	220VAC/50Hz	
Output waveshape	Pure Sine wave / Modified Sine Wave	
Transfer Time	<15 ms	
Charge Current	Max 7A	
Protection	Overload protection, surge and spike current protection.	
Noise	< 45 dB	
Ambient operating temperature	-40^0 C to $+45^0$ C	
Humidity	0-90 % (non-condensing, max)	
DC input voltage range	12 to 48V DC	
Efficiency	92 %	
Output voltage regulation	±2%	
Maximum output current	10 Amps AC (peak), 15 Amps AC (RMS)	
Total harmonic distortion	2% (Typical) to 5% (Maximum)	
Continuous battery charge output	45A DC	
Warranty	1 Year	

Torodial transformer design generates good wave form throughout the range of input voltages. Handles 200% surge. High efficiency and low self consumption maximizes power to the loads [11].

Current Load level:

Inverter 1: 70 % (2100VA)

Inverter 2: 61% (1830VA) and

Inverter 3: 100% (3000VA).

2.5: Solar System Accessories

A rooftop photovoltaic power station, or rooftop PV system, is a photovoltaic system that has its electricity-generating solar panels mounted on the rooftop of a residential or commercial building or structure [12]. Rooftop mounted systems are small compared to ground-mounted photovoltaic power stations with capacities in the megawatt range [13]. However, the rooftop solar office system (SOS) accessories are as follows:

(i). Solar panel breakers = 03 (Three)

(ii). Battery breakers = 03 (Three)

(iii). Output breaker = 01 (One)
(iv). Energy meter = 03 (Three)
(Model: TS E52A, 230V, 50Hz, 1600 imp/kWh)
(v). required cables, clamps and connectors, solar panel mounting structure etc.
(vii) S-DB (Sub-Distribution Board)

III. CONCLUSION

Study of 12KW solar office system (SOS) has been depicted in this research. The specifications of solar panels, solar MPPT, solar battery and solar inverter have been presented. The brief description of solar accessories also has been provided. The SOS has been running successfully with current load level for three inverters 70%, 61% and 100% respectively.

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REFERENCES

[1] A Novel Single-Phase Transformerless Inverter for Grid-Connected Photovoltaic Systems Guocheng San, Hanhong Qi, Xiaoqiang Guo, Yanshan University ,PRZEGLĄD ELEKTROTECHNICZNY, ISSN 0033-2097, R. 88 NR 12a/2012.
[2] [2] Application of the Concentrator PV Power System in Water Pumping, Saiful Huque and Rezaul Karim Mazumder, Proceedings of the 4th International Conference on Electrical Engineering & 2nd Annual Paper Meet 26-28 January, 2006.
[3] Design, analysis and performance study of a hybrid pv-diesel-wind system for a village Gopal Nagar in Comilla, Proceedings, National Seminar on Electronics and ICT for National Development, Bangladesh Electronics Society, Dhaka, PP.227-229, 3-4 October 2012.
[4] M. Nazrul Islam, Kh. Asaduzzaman and Mahbubul Hoq, Study and Analysis of Energy Conversion using Solar Cell, International Journal of Electrical and Power Engineering, Vol. 6, Issue 1, PP.26-31, ISSN: 1990 – 7958, Medwell Journals, 2012.
[5] https://en.wikipedia.org/wiki/Solar_panel, Available Online 2016.
[6] Datasheet, Vikram Solar, www.vikramsoalr.com, Available Online 2014.
[7] M. N. Islam, A. Rahman, H. Akhter, M. Begum, Y. Mawla, K. Asaduzzaman and M. Hoq, Microcontroller based Constant Voltage Maximum Power Point Tracking for Solar inverter applications, International Journal of Advanced Engineering, Management and Science (IJAEMS) ,Vol-1, Issue-9, ISSN:2454-1311,PIF:1.245, Infogain Publication, December 2015.
[8] Datasheet, Solar Controller MPPT, www.morningstarcorp.com, Available Online 2016.
[9] Brochure, Rimso Solar Battery, www.rimsobd.com, Available Online 2016.
[10] M. Nazrul Islam, A.K.M. S. Islam Bhuian, Masud Kamal, Kh. Asaduzzaman and Mahbubul Hoq, Simulation of a PWM single phase Grid connected or stand-alone Solar Inverter Topology with Microcontroller based MPPT, International Journal of Electrical and Power Engineering, Vol. 7, Issue 4, PP.88-91, ISSN: 1990 – 7958, Medwell Journals,2013.
[11] Datasheet, Muspana Solar Inverter, www.muspana.com, Available Online 2016.
[12] Armstrong, Robert . "The Case for Solar Energy Parking Lots". Absolute Steel. Retrieved 15 November 2014.
[13] https://en.wikipedia.org/wiki/Rooftop photovoltaic power station, Available Online 2016.