Establishment of Smart Micro Grid at National Institute of Solar Energy, New Delhi and its impact on Solar PV Plants

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***Abstract*— Modern world demands for more and more electric power, but there is limit for which nature can provide us. Again current trend in energy supply and use are patently unsustainable-economically, environmentally and socially. In order to meet the growing demand for Energy, we need to find new resources and allocate them efficiently. This is where the concept of Smart Grid comes into picture. Establishment of Smart Micro Grid in National Institute of Solar Energy, New Delhi clubs the conventional energy sources as well as renewable energy sources through a centralized controller to manage not only generation but also demand through wireless communication technology between generation and demand side. Here real time generation data are recorded from Solar PV plants through IEMU. It has been observed that through monitoring the solar energy generation resources, a lot of scope of improvement was realized and a lot of clean energy was saved or generated which was earlier getting wasted or not generated. Also from the analysis it has been revealed that continuous monitoring system for a Solar PV plant's energy generation, there has been an average increase in electrical units' generation at least by 30% in a day. The smart management does not only save energy but also manages to utilize renewable energy at a maximum level..**

Keywords-Smart Micro Grid, IEMU, Solar PV.

I. INTRODUCTION

Today, the Electricity supply industry is wrestling with an unprecedented array of challenges, ranging from a supply demand gap to rising costs and global warming [1,8]. A Smart Grid facilitates more seamless integration of renewable sources and other distributed energy resources including energy storage due to its advanced control and communication capabilities [2,3]. With an increased share of renewable such as solar and wind in the overall supply mix, utilities will reduce their carbon emissions and will be better situated to meet their respective states. In addition, customer will have access to a greater share of green power from the utility[4,10]. The control capabilities of a smart grid will also increase the ease in which customer can integrate their personal renewable energy resources such as rooftop photovoltaic system [5]. Therefore, a smart grid offers marginal benefits to renewable integration because of its communication and control improvements. Moreover, the actual interconnection technology will be improved, reducing energy losses[7]. An EPRI analysis indicate that by 2030, the implementation of a smart grid across the United States will reduce annual greenhouse gas emission by 6-211 metric tons of carbon di oxide equivalent to 2.5 to 9% of the greenhouse gas emission of the US in 2006.[6,9].

II. METHODOLOGY

A. Identification of generation point

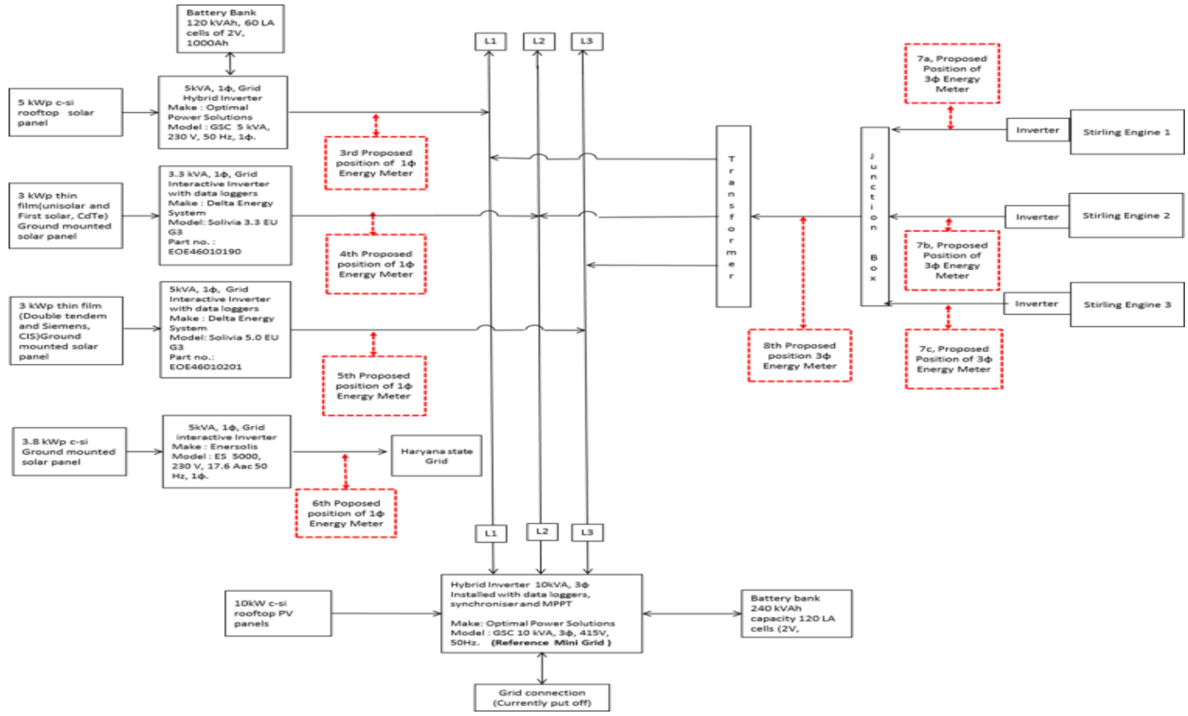
After having a survey of national institute of Solar energy following generation points have been found.

TABLE I LISTS OF RESOURCES

Sl. No.	Resources Name	Capacity	Remark
1	PV modules rooftop	20 kW	10 kW is in single phase and 10 kW is in three phase
2	PV modules ground floor	25 kW	10 kW is in single phase and 10 kW is in three phase
3	Diesel Generator	2*250 KVA 25*2 KVA	Its three phase power supply
4	Stirling Engine	3*3 kW	Its three phase power supply
5	Battery Backup	480KVAh	
6	Grid Supply	226 kW	It's a three phase supply

B. Installation of I EMUs (Intelligent Energy Monitoring Unit)

IEMU is the broad array of completely wireless and cloud hosted energy management system and services, which we deliver to the industrial and commercial establishment providing tracking of the individual consumption by various equipment's and appliances placed in the industry and the building. The system customized energy alert through SMS and E-Mail informing the customer about its energy bills and



the factors responsible for it. It is basically a wireless energy monitoring device, which consist of two parts; one is a multi-meter which measure electrical parameters such as Wattage (kW), Voltage (V), current (Amps), Power Factor (PF), Frequency (F), Line voltage (LL), phase voltage (Ln), Reactive Power (kVAr), etc.

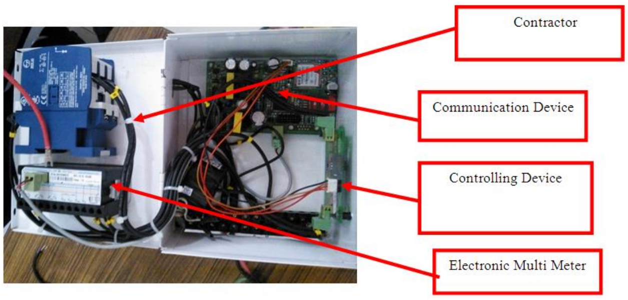


Fig 2.1 Open box view of IEMU

Another part consists of a communication device which is GSM/GPRS based and is capable of sending the above data recorded by the energy meter to the server on real time basis. Initially seven IEMUs were installed at seven different locations to track the generation and consumption data

III. Result and Discussion

Thin Film PV Plant – 2.8 kWp connected across 3.3 kVA Delta Inverter

The plant comprises of two thin film PV technologies one is of Triple Tandem by Unisolar Company and other is of CdTe technology by First Solar. The plant has a rated generating capacity of 2.8 kWp.

In fig 3.1 it is quite evident that the generation has significantly increased in the month of September as compared to the starting days in the month of July. The maximum electrical units was17 kWh per day, ha been generated during 19^{th} September to 27^{th} September 2012 while the same during the month of July had been to 4 kWh per day. The increase was around 75%. Almost zero units had been produced during this month due to rainy season

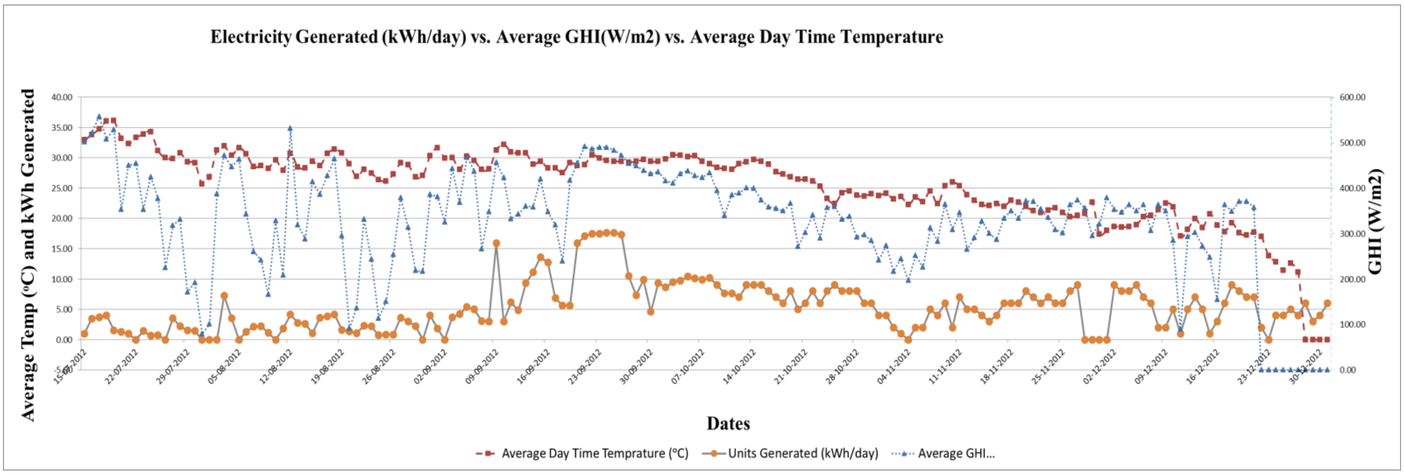


Fig 3.1 Energy generation vs. average GHI and average day time temperature for 2.8kWp thin film PV plant

In fig 3.2 it can be seen that during the month of July and August, the generation has been low due to non-availability of proper GHI, because of rainy season. It is evident that the maximum generation touched the rated peak generation for the plant during middle of the month of September. Maximum energy generation coincides with maximum power generation. During mid-September, the plant's maximum power generation reached almost to its peak rated power, i.e. 2.8 kW. From fig 3.3 CUF in the month of July was around 2% with a peak value of 5.98% while the same in the month of September was around 12.43%. There has been an increase in capacity utilization factor for the plant of around more than 80%. CUF touched the value of 26.26% on 25th Sept, close to equinox period of the Earth. Due to equinox the DNI factor of solar radiation improves and gives better power output. In the month of August, CUF was zero due to rainy weather conditions. A directly proportionate rise in the curves for electricity unit generation (kWh/day), power generation (kWp) and rise in CUF can be analyzed from graph

IV. Conclusion

It has been observed that using a continuous monitoring system for a PV plant's energy generation, there has been an average increase, calculated over a year time, in electrical units' generation at least by 30% in a day in the SEC. This increase is due to the maintenance activities and some rectification steps taken after identification of some loose inter module electrical connections, wrong orientations of modules along with inappropriate inclination angles, with dust accumulated over the modules, etc. Assuming if a 1kW system produces around 3 units a day before monitoring and after taking implementing smart mini grid under which a continuous monitoring of the plant's performance lead to take some corrective measures which in turn raised the amount of energy generation say by 30%, then the units generation by the PV modules would be around 4 units a day. Hence for a 25kWp PV plant the energy generation would increase from 75 units to 100 units a day.

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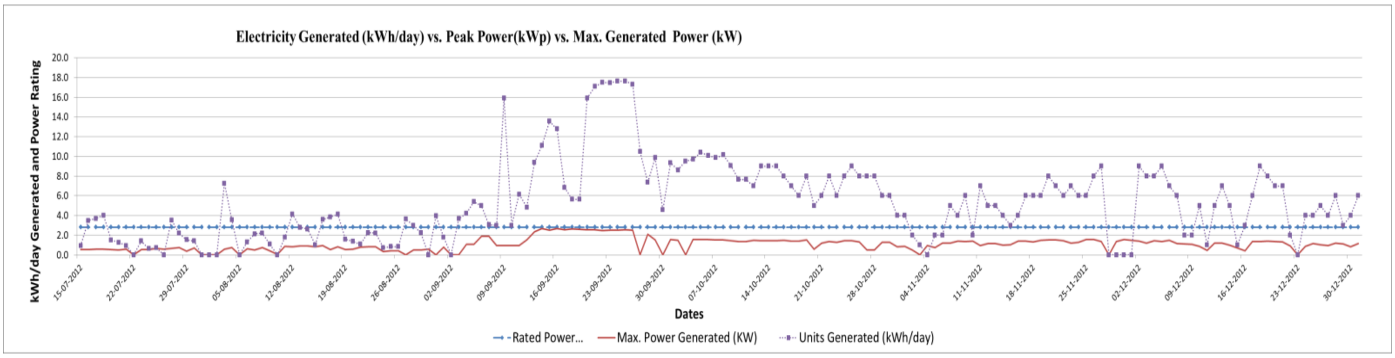

Fig 3.2 Energy generated versus rated Peak Power on daily basis for 2.8kwp thin film PV plant

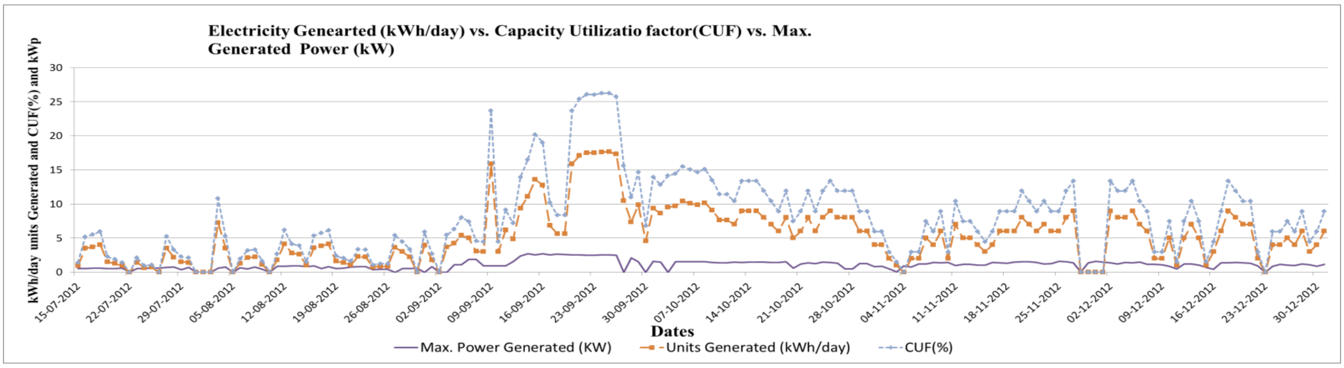

Fig 3.3 Capacity utilization factor in relation with energy generated and maximum power generated in a day for 2.8 kWp PV plant