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Generalized Photovoltaic powered system for various domestic application in rural areas

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***Abstract*—Stipulation of electricity to countryside areas is measured uneconomical by several power production companies, because of the stumpy utilization and deprived load factors. Provision of electricity to isolated communities, particularly in rural areas had some difficulties. To offer utility lines to your distant home-site, the power lines to be extended and for small amount of power consumption huge investment done by the Electricity board. Traditionally, rural loads are supplied from either stand-alone diesel power stations or via grid extensions. Such sources are sometimes not cost-effective due to the high fuel and maintenance costs of diesel stations, as well as, long distances from the grid to the loads.**

In this paper a generalized PV powered system is discussed for various applications. In connection with this a system in real time is under development. In spite of many Indian renewable energy companies are selling the system in the market, most of the customers have some reluctant to procure the system for their home applications because of high price and not user friendly. The system that we are developing is low cost; customer based sizing and easy maintenance as well.

Certain villages in India are not electrified and most of the villages are having very poor infrastructure on accessing power grids. People alive in such villages are powerless to use the basic electrical equipments like lamps, fans, televisions, radios and other electronic gadgets. The system that we are developing can be used for the above applications instantly and permanently as well. In some villages local government is providing free electricity to most of the poor in rural in the scheme of 'Single light free electrification' where too much of power is also being steal. This type of generalized PV powered system can be issued to replace the free electricity scheme so that power stealing can be avoided.

Rising costs and un-sustainability of conventional energy sources, as well as, the need for environmentally friendly energy supplies, are considered to be the main factors that have stimulated interest into designing this system for practical applications of renewable energy sources. This paper describes a latest comprehensive PV powered systems designing and its applications in detail for the benefits of the people existing in remote villages where establishing power grid is a challenging and expensive.

***Keywords*— Microcontroller, Dual charge controller, PV panel, BLDC Fan, LCD TV, Power LED**

I. INTRODUCTION

Rising costs and un sustainability of conventional energy sources, as well as, the need for environmentally friendly energy supplies, are considered to be the main factors that have stimulated interest into studies for practical applications of renewable energy sources. Certain villages in India are not electrified, where the people are unable to use the basic electrical equipments like lamps, fans, televisions and radios. Our idea will provide a better solution to non electrified zones, where the people can use all the above equipments with solar power. If utility lines are not available to remote home-site or to remote villages, Solar Electric Systems suggests natural electricity sources. Our stand-alone system (*those systems which use photovoltaic's technology only, and are not connected to a utility grid*) is very much useful for the people in the villages where power grid does not exist.

Photovoltaic powered system currently available with single battery or single stack of batteries and if the load is switched on while the battery is being charged by PV panels, it will drastically reduce the performance and efficiency of the battery, which will also decrease the life of the battery. Though dual battery charge controllers are available with automatic switching, it has got its own barriers like more maintenance, improper switching and poor sensing of voltages.

By incorporating a microcontroller in between these dual batteries or dual battery stacks, this will considerably improve the performance and efficiency as well. This paper describes the designing, constructing and testing of a microcontroller based dual battery pack or dual stack of batteries for any photovoltaic power [PV powered] applications.

Lights and appliances are carefully selected for lowest power consumption, so one can get the most benefits from the fixed amount of power available. When visiting a well designed solar electric home, we might not even notice the difference until someone tells us. Safe and free energy already on site, from sunlight can produce home electricity for most electrical needs, without the cost of extending power lines, and with no monthly power bill. This paper is the focus of solar powered home electrification.

At present electrical equipments like lamps, fans, televisions and radios are mostly run by AC. In our idea we are introducing these electrical equipments are DC based. The following components are used to build this model. The following elements are essential for the model that is designed.

II. Electrical Components

Electrical and Electronic equipments like lamps, fans, televisions, radios and LED lights fairly small power drawn. Many of these are available in low voltages. DC models use less power than their AC counterparts

PV electric module: Solar electric module convert sunlight directly into electricity with no moving parts, no maintenance, no fuel, and no pollution. This is the most environmentally friendly way to produce power. Solar electric modules last decades, Best of all, it will help to show the world bright. Solar array can also be used and the solar array consists of one or more PV modules which convert sunlight into electric energy. The modules are connected in series and/or parallel to provide the voltage and current levels to meet your needs. The array is usually mounted on a metal structure and tilted to face the sun.

Charge controller: The primary function of a charge controller in a stand-alone PV system is to maintain the battery at highest possible state of charge while protecting it from overcharge by the array and from over discharge by the loads. The set points of a charge controller are shown in Fig 1.

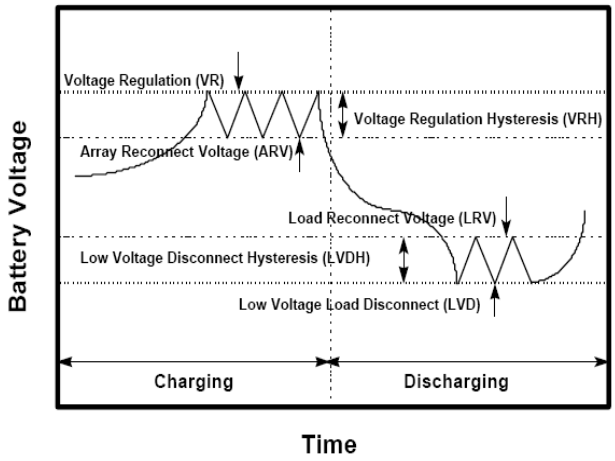

Fig 1: Charge controller set points

Battery Bank: The battery bank contains one or more deep-cycle batteries, connected in series and/or parallel depending on the voltage and current capacity needed. The batteries store the power produced by the solar array and discharge it when you need it. Fig 2 shows the battery charge state.

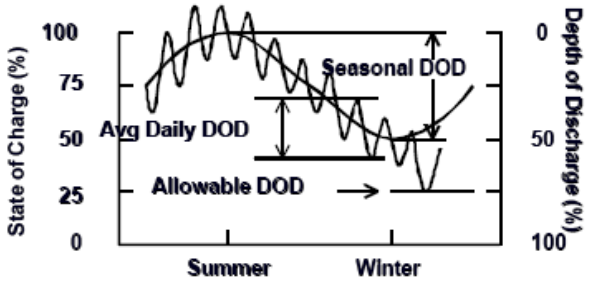

Fig 2: Battery state of charge

PV Powered DC Ceiling Fan 12V / 24V: Super efficient and quiet operating ceiling fan uses quality ball bearing 12/24V BLDC motor. Attractive, 42 inch diameter, 4 or 5 blade design with brass blade holders features a reversible dark or light wood grain blades, flush mount or 13 inch down rod mounting hardware, moulded black ABS custom housing, 4000 CFM/0.60A at 24VDC, 1800 CFM / 0.30A at 12VDC. Assembly required. *This item will require a skilled electrician to Connect to a 64 watt solar module or two 32 watt modules.*

PV Powered DC TV and Radio 12V: In present market DC TVs and Radios are available with various voltage ranges like 6V, 12V and 24V. So we can incorporate one set in our product.

PV Powered DC Power LED 12V: In present market DC operated CFL lamps are used in PV powered system. Here we have replaced by Power LED which is high bright and more lumens.

PV Powered DC Backyard and Street light 12V: In present market DC operated CFL lamps are used in PV powered street light system. Here we have replaced by Power LED which is high bright and more lumens.

III. Working

The power produced by sunlight stored in batteries. Though limited in quantity, the power from the batteries is available to be used at any time needed day or night. 60w solar panel produces about 20 amp hours per day and stored in a battery thru charge controller. 50ah Deep cycle battery delivers 36 to 40 amp hours (80%of 50ah) per day for the connected loads. All the DC loads can be operated every day 4-5 hrs in evening. Battery is sized for one day autonomy. Fig 3 shows the electrical scheme of the simple solar home system.

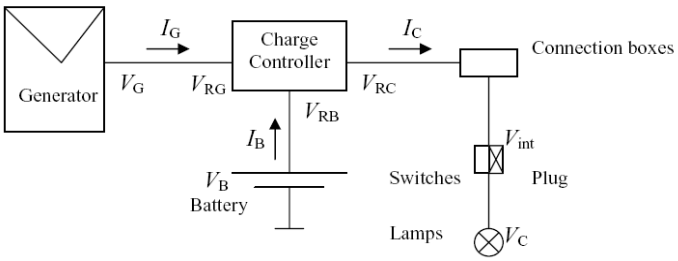

Fig 3: Electrical scheme of the Solar Home system

Introducing one more battery stack with the existing one will drastically improve the entire system efficiency. But the present charge controllers only will control single battery equipped system not the dual battery system. In this case by incorporating a microcontroller in between these dual batteries or dual battery stacks, this will considerably improve the performance and efficiency as well.

When the system is initiated first the battery-one will discharge the power to the connected loads while the battery-two is being charged by the PV panels. Once the battery-one is reached the DOD [Depth of Discharge] state, the battery-two is ready and supply the power to the loads connected while battery-one is being charged by the PV panels. This process is kept continuing and controlled, supervised by the microcontroller.

IV. MICROCONTROLLER BASED CONTROLLER

Although some PV systems can be effectively designed without the use of charge control, any system that has unpredictable loads, user intervention, optimized or undersized battery storage (to minimize initial cost) typically requires a battery charge controller. The algorithm or control strategy of a battery charge controller determines the effectiveness of battery charging and PV array utilization, and ultimately the ability of the system to meet the load demands. By incorporating a microcontroller in between dual batteries or dual battery stacks, this will considerably improve the performance and efficiency as well.

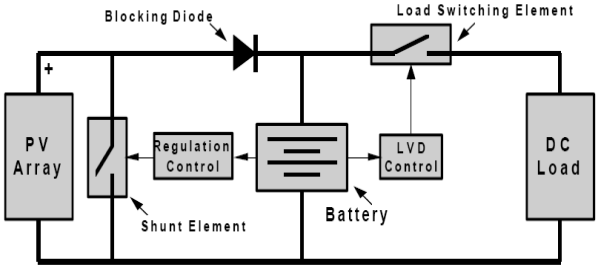

Fig 4: Basic shunt regulator

Additional features such as temperature compensation, alarms, meters, remote voltage sense leads and special algorithms can enhance the ability of a charge controller to maintain the health and extend the lifetime of a battery, as well as providing an indication of operational status to the system caretaker. Although charge controllers can be purchased with many optional features, their main function is to maintain the batteries at the proper charge level, and protect them from overcharging.

Microcontroller based controller can be designed either by using basic shunt regulator in Fig 4 or basic series regulator in Fig 5.

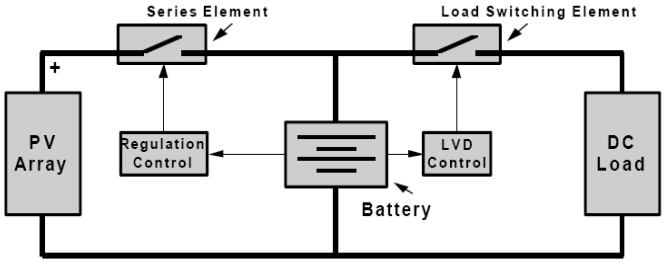

Fig 5: Basic series regulator

V. COST ANALYSIS

Cost is lowered by using special high efficiency appliances as described above, and by habits of energy conservation. The amount of power you will actually have depends on the natural energy resources at your site, and how much equipment you install to collect the energy

Power Grid particulars by TNEB

Part A: TNEB accessories + Service Charges for new Wiring

1.	GI wire	=	Rs. 100/-
2.	PVC Wire	=	Rs. 500/-
3.	Service Pipe	=	Rs. 100/-
4.	Bobbin	=	Rs. 100/-
5.	Main and Service Board	=	Rs. 100/-
6.	Main Switch	=	Rs. 150/-
7.	16A Fuse Unit	=	Rs. 100/-
8.	Earth link, accessories	=	Rs. 100/-
9.	EB Service Charges	=	Rs. 500/-
10.	Caution Deposit	=	Rs. 2000/-
11.	Mason works	=	Rs. 500/-

	Part A Total	=	Rs. 4250/-

Part B: Equipments for Simple House

1.	Tube Light Set 3X Rs300/=		Rs. 900/-
2.	Fan 2Nos X Rs. 900/-	=	Rs. 1800/-
3.	B/W TV 36cm 1No	=	Rs. 2500/-
4.	Radio 1No	=	Rs. 150/-
5.	Street Light 1No	=	Rs. 9000/-

	Part B Total	=	Rs.14, 350/-

Part C: In-house wiring expenses

1.	Wires, Switches, Boards	=	Rs. 2000/-
2.	Labour Charges	=	Rs. 1000/-
3.	Miscellaneous Charges	=	Rs. 500/-
	Part C Total	=	Rs. 3500/-

Part D: Energy Tariff per month

TubeLightSet3Nos x 40w x 5hrs	= 600 watt hrs / day
Fan 2Nos x 80w x 12hrs	= 1920 watt hrs / day
B/W TV 36cm 1No x 24w x 5hrs	= 120 watt hrs / day
Radio 1 no x 1w x 12 hrs	= 12 watt hrs / day
Total watt hours consumed	= 2652 watt hrs / day

Monthly Consumption
(31 Days X 2652 watt hrs) = 82,212 Watt hrs / month
In Kilo Watt hrs
(82,212 watt hrs / 1000) =82.212 Kilo Watt hours / month

Monthly Tariff (Ave Rs. 3/-X82.212kwh)=Rs. 246.64 / month

Yearly Tariff (12 months X Rs. 246.64) = Rs. 2,959.68 / year

Rounded off to =Rs.3000/- per year

Part A	Total	=	Rs. 4,250/-
Part B	Total	=	Rs. 5,350/-
Part C	Total	=	Rs. 3,500/-
Grand Total (Power Grid)		=	Rs. 13,100/-

WITH

1 year energy cost (13,100/- + 3,000/-)	= Rs.16, 100/-
2 year energy cost (13,100/- + 6,000/-)	= Rs.19, 100/-
3 year energy cost (13,100/- + 9,000/-)	= Rs.22, 100/-
4 year energy cost (13,100/- + 12,000/-)	= Rs.25, 100/-
5 year energy cost (13,100/- + 15,000/-)	= Rs.28, 100/-

Photovoltaic system particulars:

Part A: Solar Panel and its Accessories

1.	Solar panel 12v / 80w	=	Rs. 8, 000/-
2.	Charge Controller 12v / 10A	=	Rs. 1, 000/-
3.	Battery Deepcycle12v / 60ah	=	Rs. 6, 000/-
	Part A Total	=	Rs. 15,000/-

Part B: Equipments for Simple House

1.	LED Light Set	3Nos X Rs. 750/-	=Rs. 2,250/-
2.	Fan (12V/72w)	2Nos X Rs. 3,200/-	=Rs. 6,400/-
3.	B/W TV 36cm	1No	=Rs. 1,500/-
4.	Radio	1No	=Rs. 100/-
	Part B Total	=	Rs. 10,250/-

Part C: In House wiring expenses

1.	Wires, Switches, Boards	=	Rs. 2,000/-
2.	Labour Charges	=	Rs. 1,000/-
3.	Miscellaneous Charges	=	Rs. 500/-
	Part C Total	=	Rs. 3500/-

Part A	Total	=	Rs.15, 000/-
Part B	Total	=	Rs.10, 250/-
Part C	Total	=	Rs. 3, 500/-
	Grand Total	=	Rs. 28,750/-

VI. Comparative Cost Analysis

Sl.No	Work and Particulars	Power Grid Price	Solar Home system Price[SHS]
1	TNEB accessories + Service Charges for new Wiring	Rs. 4,250/-	Nil
2	Equipments for Simple House	Rs. 5,350/-	Rs. 10,250/-
3	In-house Wiring expenses	Rs. 3,500/-	Rs. 3,500/-
4	Solar Panel and its Accessories	Nil	Rs. 15,000/-
	Total Cost	**Rs. 13,100/-**	**Rs. 28,750/-**
Energy cost for a year Rs. 3,000/- [Power Grid] With			
1	One-year Energy Cost	Rs. 16,100/-	Nil
2	Two-year Energy Cost	Rs. 19,100/-	Nil
3	Three-year Energy Cost	Rs. 22,100/-	Nil
4	Four-year Energy Cost	Rs. 25,100/-	Nil
5	**Five-year Energy Cost**	**Rs. 28,100/-**	Nil
With			
6	Ten-year Energy cost	Rs. 56, 200/-	Nil
7	Fifteen-year Energy cost	Rs. 84, 300/-	Nil
8	Twenty-year Energy cost	Rs.1,12, 400/-	Nil
9	Thirty-year Energy cost	Rs.1,68,600/-	Nil

Total Savings in thirty years
Rs. 1, 68,600/- minus Rs. 28,750[SHS] = 1, 39,850/-

VII. Implementing Stage

We are planning to test and implement this product in one rural area near by our college.

Stage1: Once we receive the materials, we the team will select one of our mechanical lab to design the prototype. We are planning to buy few components in ready made because the cost of fabrication is more than buying ready made one. For instance, designing a DC TV will cost more than the one which is available in the market. Like wise DC fans and DC radios.

Stage 2: To fix the panel, a mounting stand to be fabricated. One of our team member plans to do that stand. Another member will design the charge controller to control the battery charge.

Stage3: Once all are ready, we the members join together and start assembling all the components and interconnect. Once assembling and interconnection done, we go for testing and measure the efficiency.

Stage4: Near by our panchayat Ketti, lot of rural villages are not electrified. We are planning to implement few houses in those non-electrified villages. Number of units depends upon the fund availability.

VIII. Conclusions

The planning of a PV implementation programme is a fairly complex process. A large number of issues have to be taken into considerations and many individual tasks are necessary. Neglect of some of these tasks may result in problems later on or, in the worst case, to failure of the programme. This paper lists issues to be considered which are typical for most PV programmes or projects. However, each programme is different and special circumstances will require special consideration. Therefore it is necessary to assess the requirements of each programme individually.

Acknowledgment

I would like to thank the experts of IIT, Chennai and NIT, Tiruchirappalli. Every effort has been made to ensure the accuracy of the information within this report. However, mistakes with regard to the contents cannot be prohibited.

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