Implementation of Solar Power DC Distribution lighting system with Intelligent Controller

[1]G Sandeep,
Research Scholar
JNTUK Kakinada,
AP, India.
e-mail:sandeepgogula@gmail.com

[2] Dr. V. S. Vakula,
Asst Professor, Dept. of EEE,
JNTUK- University College of Engineering
Vizianagaram, India.
e-mail:dr.vakulavs.jntu@gmail.com

Abstract— Photovoltaic (PV) are basically DC power sources which are green power sources belongs to the study of renewable energy sources (RES). Many nations have started taking steps to meet the required electrical energy demands through different renewable resources to improve the local impact, as the standard of living is increased. One of the main dc distributions in lighting is Street lighting and is the infrastructure which should meet the consumer requirements, expansions, and growth. Countries may have more burdens if still using High Pressure Sodium (HPS) lamps for street lighting as they are of A.C. Nowadays, LED light technology becomes a candidate as it surpass the HPS lamp from both energy and money saving.

In this paper a Hardware setup of solar lighting system is proposed and designed which consists of 250W panel output with 12 volt supply and 120 volt supply based on the load configuration and low voltage based loads like led lamp with number of sets to glow continuously for hours based on requirement and battery capacity. Nearly twenty times less than ac voltage is carried out and proportional to illumination requirement lighting loads are designed which reduces the power and energy consumption. Here, solar energy is collected with the aid of a solar panel and thus, a battery is charged with the help of a simple optimized charging controller. The generated solar energy is used to charge the battery and it is discharged by the load. A dc supply is given by the battery when solar power is not available. These devices can be used for small-scale lighting applications in remote areas that are far away from the power grid.

Keywords*- Solar powered appliances, Energy optimization, charge controller*

*****

I. INTRODUCTION

Solar lighting system is the use of natural light to provide illumination. Solar lighting system is the technology of obtaining usable energy from the light of the sun using semi conductor materials and this is energy efficient lighting technology [1]. Solar panels are devices that generate power from the sun by converting sunlight into electricity with no moving parts, zero emissions and no maintenance. They are used in residential, commercial, institutional and light industrial applications. A Solar lantern is a simple application of solar photovoltaic technology, which has found good acceptance in rural regions where the power supply is irregular and scarce. Even in the urban areas people prefer a solar lantern as an alternative during power cuts because of its simple usage.

The electricity is stored in batteries and used for the purpose of lighting whenever required. These systems are useful in non-electrified rural areas and as reliable emergency lighting system for important domestic, commercial and industrial applications. The SPV systems have found important application in the dairy industry for lighting milk collection chilling centers mostly located in rural areas.

Solar Street Light system is designed for outdoor application in un-electrified remote rural areas. This system is an ideal application for campus and village street lighting. The system is provided with battery storage backup sufficient to operate the light for 10-11 hours daily. The construction of a solar lighting system serves as a means of reducing energy imports and dependence upon oil and gas, which mitigate the risk of fuel-price volatility and supplies energy for small-scale lighting applications when and where electricity is most limited and most expensive.

II. CHARGE CONTROLLER

A charge controller is charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against over voltage, which can reduce battery performance or life span, and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer either a standalone device, or to control circuit integrated within a battery pack, battery powered device, or battery charger. Charge controllers [2] are sold to consumers as separate devices, often in conjunction with solar or wind power generator, for uses such as boat and off the grid home

 ISSN: 2454-4248
160 – 162

battery storage systems. In solar applications, charge controllers may also be called solar regulators. Some charge controllers / solar regulators have additional features, such as a low voltage disconnect (LVD), a separate circuit which powers down the load when the batteries become overly discharged (some battery chemistries are such that over-discharge can ruin the battery). A series charge controller or series regulator disables further current flow into batteries when they are full. A shunt charge controller or shunt regulator diverts excess electricity to an auxiliary or "shunt" load, such as an electric water heater, when batteries are full.

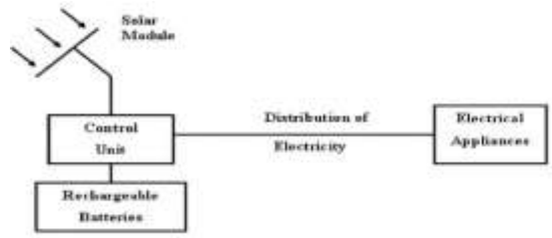

Fig 1.1 Basic Block Diagram

Charge controller will to harvest the available energy from the PV array and deliver it to the batteries[3][4]. The charge controller terminals indications are shown in figure.

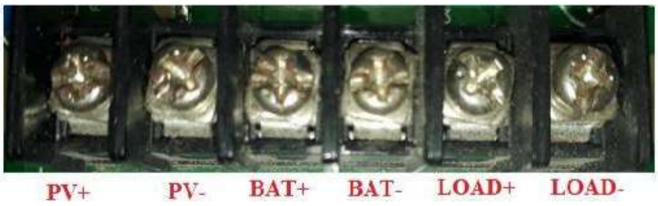

Figure 1.2 Controller Terminals

III. PANEL INTERFACE

Load Optimization can be done using below controller configurations based on availability of dc distribution from the solar panel and the battery which can be utilised day time and night time based on the designing of the charge controller[5][6].

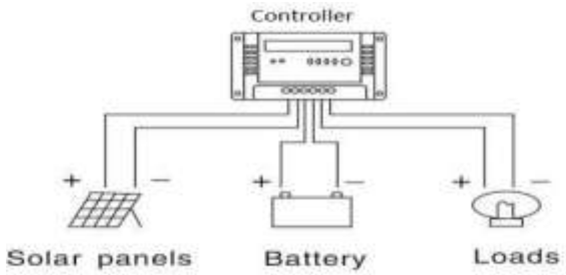

Figure 2.1 Power Supply

Charge Controller State			
PV>BV	State	PV<BV	State
Charge on	Turn On	Charge Off	Turn Off

Fig 2.2: Charge Controller states

TIME	VOLTAGE(V)	CURRENT(A)	POWER(W)
DY-1			
12:00 PM	108.4	0.47	50.948
1:00 PM	99.5	0.15	14.925
2:00 PM	103	0.7	72.1
3:00 PM	101.2	0.26	26.312
4:00 PM	98.6	0.15	14.79
5:00 PM	102	0.12	12.24
DY-2			
1:30 PM	102	0.51	52.62
2:30 PM	100.1	0.36	36.035
3:30 PM	101.2	0.25	25.3
4:30 PM	99.4	0.13	12.922
DY-3			
11:00:00 AM	102.6	0.22	22.572
12:00 PM	100.8	0.24	24.192
1:00 PM	102.8	0.49	50.372
2:00 PM	100.9	0.4	40.36
3:00 PM	101.4	0.16	16.224
4:00 PM	97.9	0.09	8.811
5:00 PM	96.4	0.06	5.784

TIME	VOLTAGE(V)	CURRENT(A)	POWER(W)
DY-4			
11:30:00 AM	101.4	0.1	10.14
12:30 PM	102.8	0.276	28.3728
1:30 PM	101	0.2	20.2
2:30 PM	102.6	0.28	28.728
3:30 PM	101.3	0.15	15.195
4:30 PM	102.5	0.14	14.35
DY-5			
11:06 PM	104.9	0.01	1.049
13:36	103	0.6	61.8
3:00 PM	100	0.21	21
4:30 PM	108.9	0.1	10.89
DY-6			
1:30 PM	101.7	0.19	19.323
14:36	100.8	0.2	20.16
15:36	96.4	0.1	9.64
16:36PM	97.3	0.08	7.784
DY-7			
12:36 PM	102.1	0.2	20.42
1:30 PM	104	0.3	31.2
2:30 PM	100.4	0.15	15.06
3:30 PM	101.5	0.12	12.18
4:30 PM	99	0.09	8.91

Table 2.1: Realtime Power variations observation table for specific period

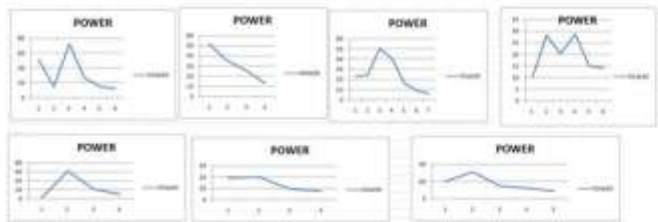

Figure2.3: Real time Power Variations for Optimized Power tracking system design as per table 2.1

IV. HARDWARE IMPLEMENTATION

Figure3.1 Single unit led lighting

Figure3.2 Output for Street lighting

Figure3.3: Design of LED lighting as per required specifications

V. CONCLUSION

In this paper solar power dc distribution is implemented on dc loads mainly led lighting systems. In general hardware design is done based on the requirement of light loads. At present 300 watts led lamp is designed using one watt leds and all are cascaded in series and parallel combination to get 30 watts each led stack output. To dissipate the heat produce by the led set when they are in on for longer time, the led setup is mounted on aluminium sheet. In this paper low voltage dc distribution is carried out for lighting and an experimental setup prepared each 30 watts and tested with 300 watts solar panel. To control the solar power and to maintain continuity of lighting for longer durations under absence of sunlight the setup is interfaced with charge controller and battery. The power consumption is reduced by dc lighting with nearly same illumination as that of choke based tube lights which consumes 50W per setup and nearly 30 watts is saved per setup with reduced overall cost of the system. This experimental prototype setup can be extended as per requirements and easily can implement in real life situations.

REFERENCES

[1] Solar Lighting Systems Module Trainers Textbook by Ministry of New and Renewable Energy Government of India

[2] Y. Fang and X. Ma, “A novel PVmicroinverter with coupled inductors and double-boost topology,” *IEEE Trans. Power Electron.*, vol. 25, no. 12,pp. 3139– 3147, Dec. 2010.

[3] L. Zhang, K. Sun,Y. Xing, L. Feng, andH.Ge, “A modular grid-connected photovoltaic generation system based on DC bus,” *IEEE Trans. Power Electron.* vol. 26, no. 2, pp. 523–531, Feb. 2011.

[4] Y. Jiao, F. L. Luo, and M. Zhu, “Voltage-lift-type switched-inductor cells for enhancing DC-DC boost ability: Principles and integrations in Luo converter,” *IET Trans. Power Electron.*, vol. 4, no. 1, pp. 131–142, Jan. 2011.

[5] M. Islam and M. A. B. Sarkar, "An efficient smart solar charge controller for standalone energy systems," *2015 International Conference on Electrical Drives and Power Electronics (EDPE)*, Tatranska Lomnica, 2015, pp. 246-251. doi:10.1109/EDPE.2015.7325301 http://www.eai.in/club/users/thirumalai/blogs/16852

[6] Renewable Energy Sources by G.D.Rai, Khanna publishers

[7] ChedlyBelhadj-Yahya, "Performance Monitoring of Solar Stand Alone Power Systems", *IEEE International Energy Conference-2010*, pp. 412-416, Dec. 18– 22, 2010.