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Integrated Photovoltaic System Used as an Alternative Power Source

This paper presents a solution to use solar energy as an alternative source of electricity to conventional sources. The solution is to use a compact photovoltaic system integrated into a micro smart grid. The studied photovoltaic system is used into concrete application for the power supply lighting in a didactic laboratory.

Keywords: photovoltaic system, lighting, monitoring, alternative power source, smart grid

1. Introduction

Energy issues have become the primordial in recent years due to the depletion of fossil fuel resources, their price variations and political dependence of nations they delivers [6].

Use of renewable energy resources is gaining more ground, because continuous increase in the price of fossil energy carriers and lower stocks management respectively waste resulting from nuclear energy [6].

A challenging problem for experts and researchers in the energy sector refers to the integration of renewable energy sources in the electricity distribution networks.

To resolve this problem has developed the concept of smart grid [3].

A smart grid is an electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources to meet the varying electricity demands of end-users. Smart grids coordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimising costs and environmental impacts while maximising system [5].

In Figure 1 is shows an example of smart grid.

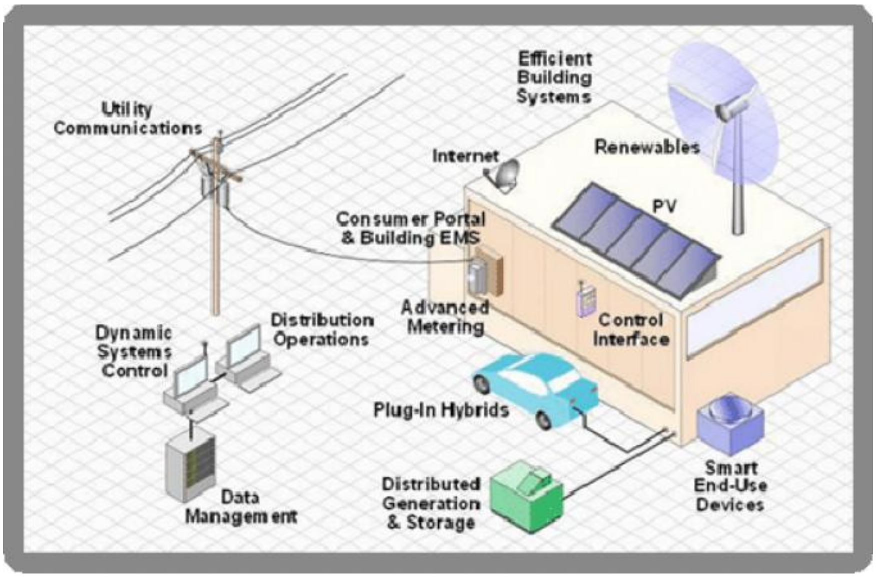

Figure 1. Smart grid example [4]

This paper presents to interconnection possibilities of a stand-alone photovoltaic system with other sources of electricity generation. Also the PV system has functions for integration on a micro smart grid.

2. Description of the Photovoltaic system

The photovoltaic system presented in the paper is realized in a compact construction that is coupled directly to the battery, and network with photovoltaic panels. This topology can power any electrical equipment for domestic and industrial applications in power limit of the inverter.

The advantage of this topology is given by the fact that it integrates all the equipment including AC and DC panels with fuses and protection from electromagnetic induction (figure 2). These advantages drastically reduce labor costs for installation and wiring of the system.

Photovoltaic system called Flex Power One is manufactured by OutBackPower Systems [7].

FLEXpower ONE is an integrated power system solution designed to be quick to install and easy to use.

The FLEXpower ONE System is intended for off-grid and on-grid applications up to 3.6 kW. It is intended for use with photovoltaic (PV) modules for harvesting energy and a battery bank for energy storage.

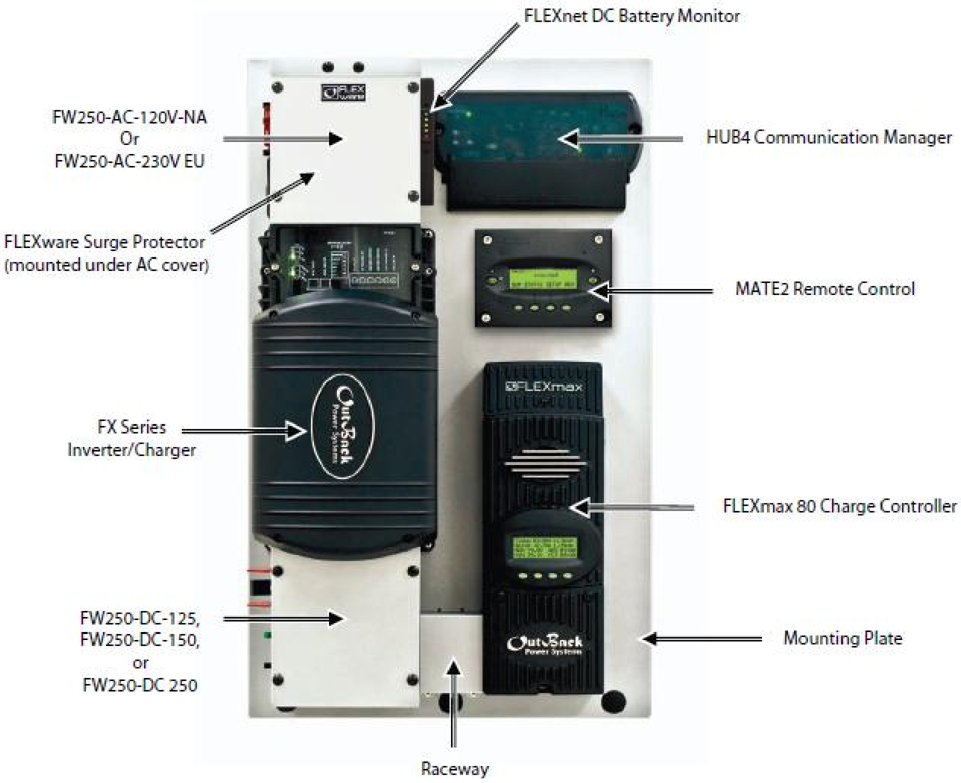

Figure 2. Basic components of Flex One Power system [7]

The system can be installed in various configurations, either as independent alternative system or as back-up system concept (SBC) which is automatically achieved energy management (figure 3).

On-grid configuration

In on-grid applications, the FLEXpower ONE can use the grid power as the primary power source or as the backup source of power. If the FLEXpower ONE is used as backup to the grid, the FLEXpower ONE will take over when the grid fails. If the FLEXpower ONE is used as the primary source, the grid power will be used when the batteries have been drained. In this situation, the AC power or PV harvest can be used to recharge the battery bank.

Off-grid configuration

In off-grid applications, the FLEXpower ONE can use the harvested energy from the battery bank as the primary power source. An AC generator can also be connected to support the system when required.

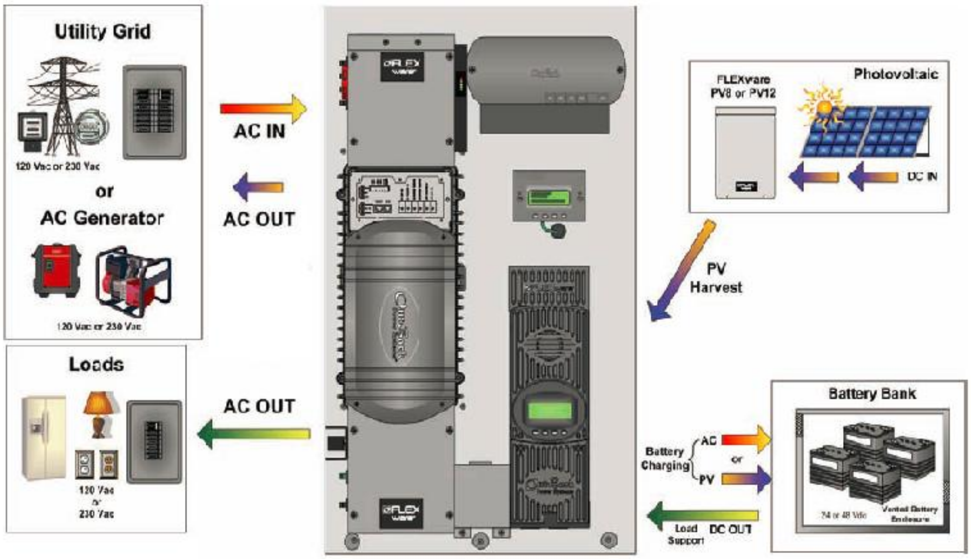

Figure 3. Flex One Power system configurations [7]

Grid-interactive configuration

In grid-interactive applications, grid power is used to run the loads. When excess PV is available from the batteries, the FLEXpower ONE supports those loads with the PV. When the PV exceeds the load requirements, the FLEXpower ONE sells that excess power back through its input, to the utility grid. When the utility grid is not available, the FLEXpower ONE takes over to run the loads with PV and energy stored in the battery bank.

3. Application used for Photovoltaic system

As embodiment, the photovoltaic systems presented in this paper provide the power supply to electric lighting in the laboratory of the Faculty of Electrical Engineering of Craiova [1].

Using dedicated software DIALUX the lighting design was done. This program has many features on the design and simulation of lighting system [1].

Figure 4 presents one of the program's dialog boxes and figure 5 presents the global preview window of lighting installation.

Figure 4 shows the dialog box that allows configuration program room geometry, the choice and positioning of lighting lamps.

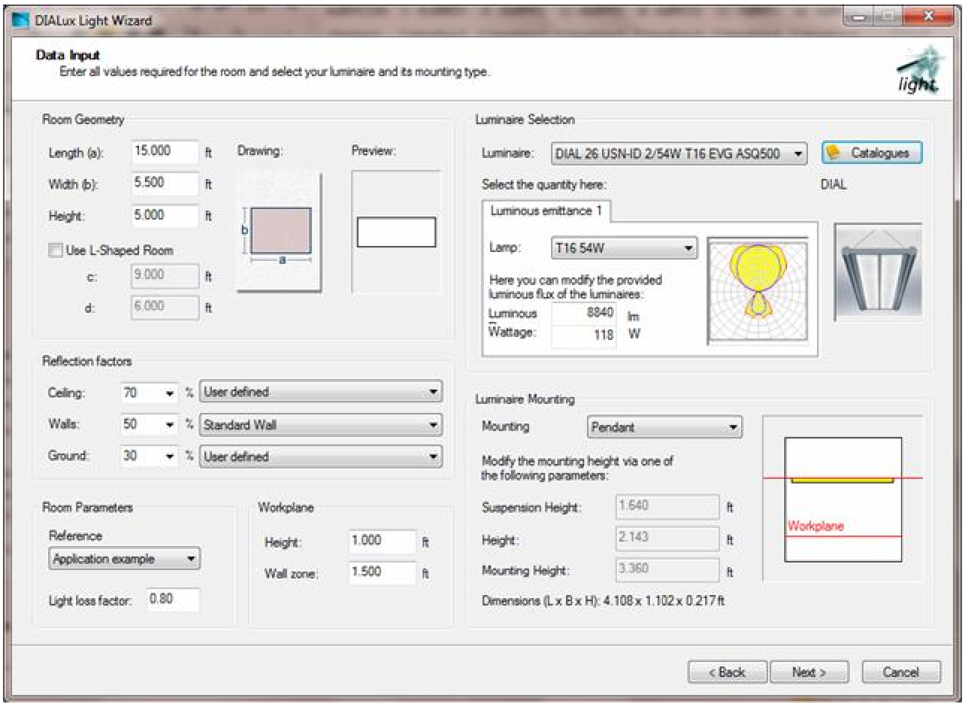

Figure 4. Dialog window of DIALUX program

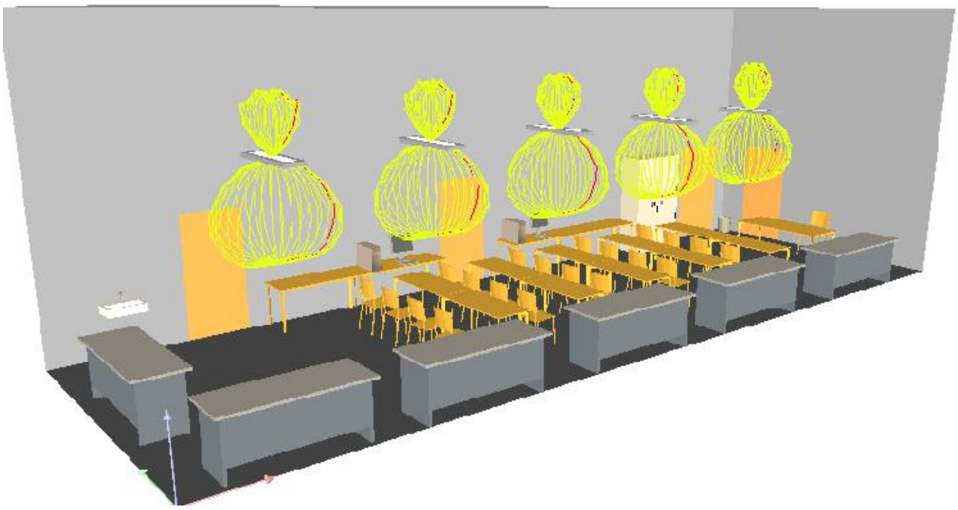

Figure 5. Global examination of lighting system for laboratory

Output Data
Total luminous flux: 30939 [lm]
Total power: 590 [W]
Light loss factor: 0.80
Wall zone: 1.5 [m]
Uniformity to work plane: 0.67; E_{min}/E_{max}=0.552
Luminaire rapport: walls/work plane: 0.35, ceiling/work plane: 0.45
Specific power: 7.87 [W/m^2]=1.89[W/m^2]/100[lx] at surface: 75 [m^2]

4. Monitoring and control of Photovoltaic system

4.1. Local monitoring and control of Photovoltaic system

A renewable energy system requires some combination of inverter/chargers, batteries, charge controllers, and a renewable energy power source, as well as often interfacing with a generator. All of these components need to be adjusted and monitored for optimum performance. The MATE3 System Display and Controller (MATE3) provide that ability to monitor and program each PV system component (figure 6).

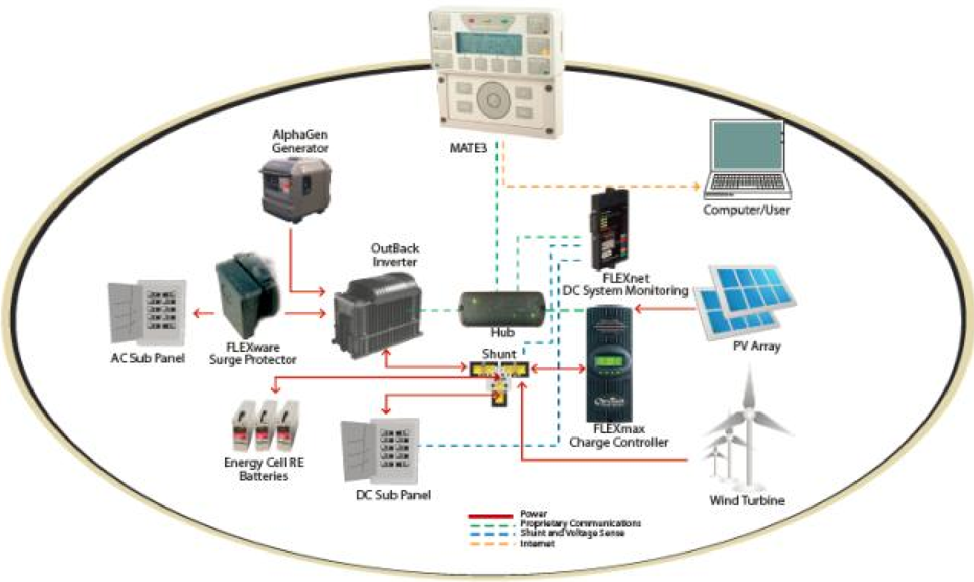

Figure 6. Configuration of MATE 3 monitoring system [7]

In Figure 6 is showing the frontal display and control elements of the monitoring system MATE 3.

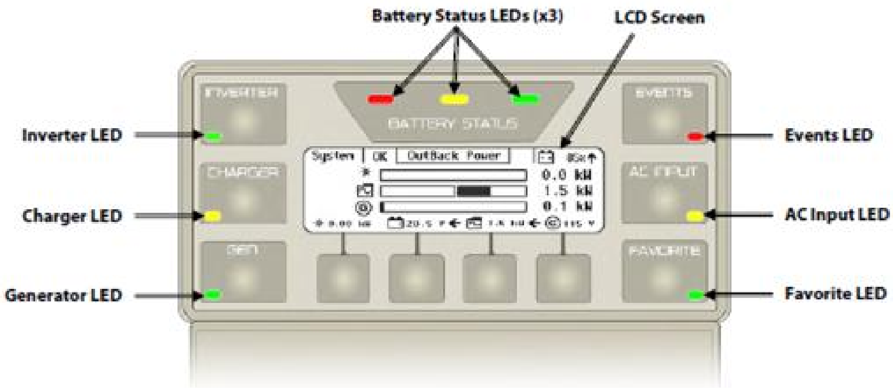

Figure 7. The display and control elements of MATE 3, [7]

MATE 3 monitoring and control system allows display photovoltaic system parameters both as numerical and graphical type (figure 8).

a) b)

Figure 8. Photovoltaic system parameters display: a) numeric display; b) graph display

The MATE3 provides an option for an isolated port for PC communication in the form of a USB cable. The USB card must be installed for this function to work . The MATE3's Serial Data Stream menu item must be set to Enabled in order for it to send data streams. If this command is not enabled, direct commands are required for any communications.

The USB card operates with Windows and Linux systems, and Mac OS X 10.7 or later.

The initial baud rate and other settings of the USB card are not necessarily a known value, particularly if the card receives new settings from the PC upon connection. The USB card must be set with the PC to match the MATE3.

The data exported from the USB card to PC are in CSV format and can be easily processed to be displayed in graphical form as presented in Figure 9.

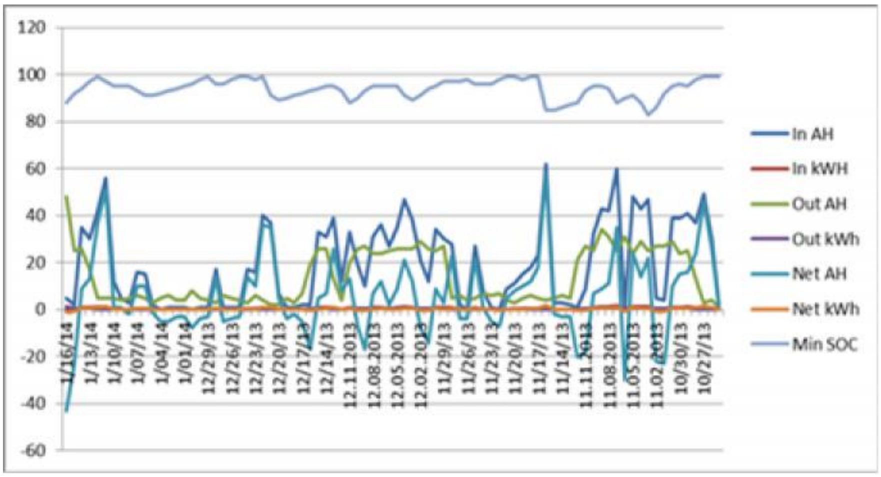

Figure 9. Graphic evolution of the PV system parameters

4.2. Remote monitoring of Photovoltaic system

Remote monitoring of the PV system is achieved by a communication network via the Internet (figure 10).

Information on the functionality of the photovoltaic system are obtained by accessing an Internet browser, the photovoltaic system are identified based on an IP (figure 11).

The inverter monitors the state of charge of the storage battery and the input mains. All consumers are coupled to the inverter output, and they can not exceed the maximum instantaneous power supplied by this type of inverter. MPPT solar controller inverter communicates the existence of alternative energy production, it engages consumers in batteries.

In the case in which the discharge achieves the programmed state of the storage battery, the inverter is coupled to the network, which allows recharging of their direct power consumers. Batteries will receive energy and PV panels connected to the system. This makes daytime amount of energy required consumers to be compensated by energy intake from these solar panels.

The system is accessed through the Internet from anywhere, having the opportunity to provide information in the numerically or graphically. The production system reports by email every day, week and month of the year to facility achievement of statistics on PV system.

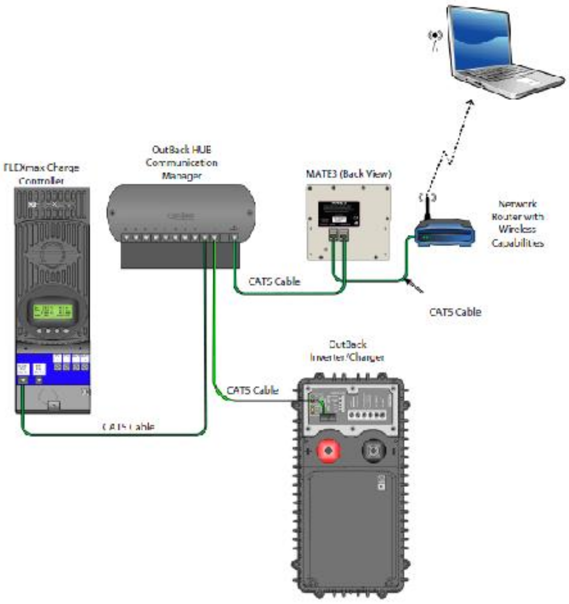

Figure 10. Interconnecting elements of the monitoring system [7]

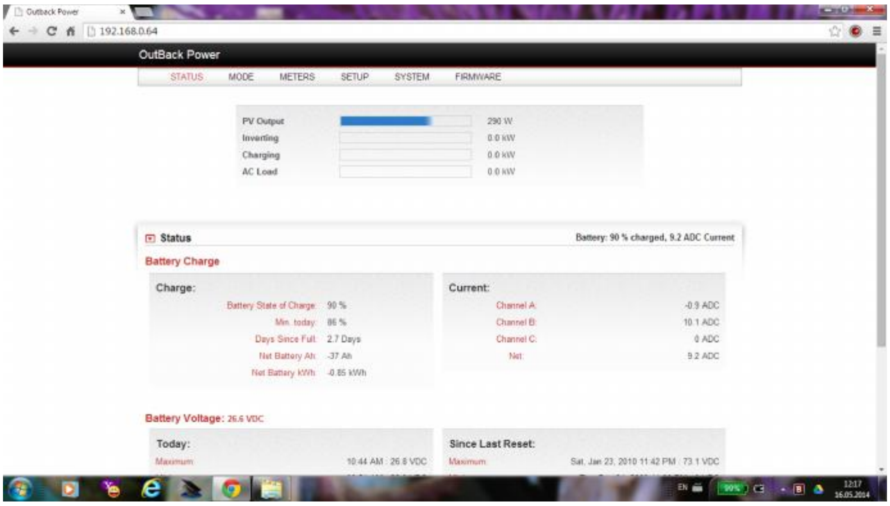

Figure 11. Web page of remote monitoring system

4. Conclusions

Electrical architecture of the system has the capability to configure a production of electricity from solar maximum system capacity PV can achieve maximum production of 360 - 400KWh/month. This production completely cover energy needs for the chosen application. Also, this type of system can be upgraded in stages depending on the available budget without significant installation costs.

Acknowledgment

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