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Hybrid Power Management Using Micro-Controller

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Abstract: **This paper represents optimization of power management system (PSM) for standalone micro-grid with hybrid power generation. We are going to generate hybrid power by using photovoltaic model and small wind mill. The output hybrid power is not constant and continuous therefore if in case of generation is less than load demand then by managing loads by using micro-controller. If hybrid power is reduced and micro-controller is not present then there is stress on micro-grid. Therefore there will be possibility of system failure to avoid this we are managing loads by using micro-controller. Here by managing loads we have done optimized use of generated energy. Therefore efficiency of the system increases. Renewable energy is the future of energy sector for that its management is useful in future.**

Keywords: **Photovoltaic Model, Windmill, Micro-grid, Microcontroller, Hybrid Power.**

I. INTRODUCTION

Distributed generation (DG) may result in enhanced continuity of service and in increased customer participation to the electricity market. These opportunities are certainly supported by allowing the operation of a small portion of distribution networks (both on medium and low voltage levels) in islanded conditions. The literature on the subject defines micro-grids as small-scale power systems equipped with embedded generators and suitable control systems able to supply local electrical and thermal demands in islanded operation.

In this definition, micro-grids are also designed to connect seamlessly to the public distribution network and, after that, disconnect when appropriate. In household applications, the above-mentioned capability to operate in islanded mode is permitted by the presence of energy storage devices and by the implementation of automatic scheduling systems that make use of communication and aggregation features allowing the operation and control of microgrids as single entities.

Within this context, there is a general interest for the utilization of kilowatt (kW)-class fuel cells (FCs) in residential applications. Indeed, compared with other conventional small generators, FCs, and in particular the proton exchange membrane (PEM) ones, promise higher cogenerative performance, clean and silent operation, and cost-effective supply of power. Recently, Erdinc and Uzunoglu provided a review of different architectures of systems powered by PEM FCs, also in combined use with other power supply and energy storage units, in order to build so-called hybrid systems. Various energy management approaches have been proposed in the literature in order to handle the characteristics of different power generators and storage systems.

With reference to integrated PEM FC and battery systems for electric vehicle applications, Thounthong propose a cascade control of FC-current, battery-current, and battery state-of-charge with a limitation function of the dc-link voltage. Concerning residential applications, hybrid energy storage systems composed by regenerative FCs integrated with batteries, or ultracapacitors, have been compared in order to assess the criteria for the exploitation of the different energy and power density values of the components.

2. BLOCK DIAGRAM OF HYBRID POWER MANAGEMENT

There are many possible configurations of hybrid power systems. One way to classify systems architectures is to distinguish between AC and DC bus systems. Figure 1illustrates the block diagram of this configuration

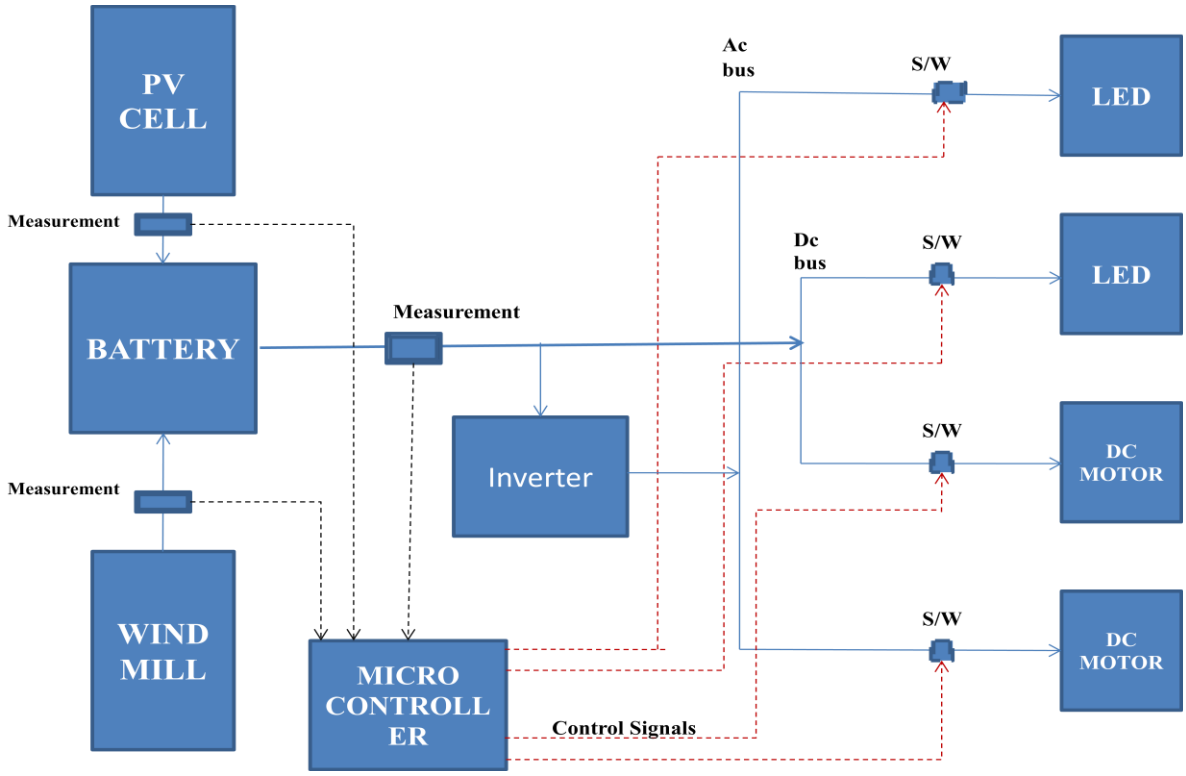

Fig1

In this paper we can generate the energy from hybrid plant (power). Hybrid power means we can generate energy from two and more energy sources. In this paper we can use "Photovoltaic cell" and "Wind energy" for generation of energy.

In this generated energy from photovoltaic cell and wind energy can be stored into battery. Also we can measure generated energy from photovoltaic cell and wind energy by using micro-controller. Also we can measure the charging percentage of battery.

In a hybrid power management system we can manage the load according to battery percentage. Such as if battery is 100% charge then all loads will be ON and If the battery is below 70% charge according to given by microcontroller priority any one of the load is OFF. Micro-controller gives a different priority for the different load according to battery charging percentage.

DC bus systems are those where the renewable energy components and sometimes even the backup diesel generator feed their power to a DC bus, to which is connected an inverter that supplies the loads. This is for small hybrid systems. Large power hybrid systems use an AC bus architecture where wind turbines are connected to the AC distribution bus and can serve the loads directly. The configuration used to be evaluated in this thesis has a DC bus which combines the DC output of the PV module, the DC output of the wind turbine, and the battery bank.The AC bus of this configuration combines the output of the bidirectional inverter, the output of the back-up diesel generator and the load. This parallel configuration requires no switching of the AC load supply while maintaining flexibility of energy source, but the bidirectional power inverter shall be chosen to deal with this mode of operation.

- Solar photovoltaic panel
- Wind generator
- Charge controller
- Storage unit (battery)

These units have been discussed in detail in next sections.

Solar Photovoltaic Panel:

The basic working principle of a solar panel is that it contains silicon cells which have small p-n junctions inside them. The incident photons create free charge carriers. These charge carriers are separated through the junction and then electric current is generated. The different arrangements of the silicon cells generate different levels of voltage and current.

The solar photovoltaic panel is selected on the basis of system requirements and before selecting the panel it should be kept in mind that it is preassembled and its specifications cannot be altered thereafter. The battery used to store charge is of 150Ah capacity. The selection of the solar panel depends on the time it takes to charge the connected battery.

To calculate the charging time the following equation can be used:

*peak hour required=V(batt) *Capacity(batt)/power(SPV)*………(1)

This equation can also be written as

*Power (SPV)=V batt *Capacity(batt)/peak hr required* ………(2)

Wind Generator

Analysing the wind pattern and designing the wind turbine for this system proves to be most challenging work. Since the average wind speed at this area is around 3.5m/s. But the provided data suggests the wind speed on an average basis in which there are times when wind blows with high speeds and there are times when there is no wind. During night time the speed of wind is quite high of the order of 8-12 m/sec and this system will convert that kinetic energy into electrical energy. The maximum power available through wind resource is given by this equation [1]: -

$P=0.5*\rho*A*V^3$(in watts)

Where P= Power

ρ=density of air (1.2kg/m3)

A=Area perpendicular to the flow of wind

V=Wind velocity

The above equation only gives theoretical power but in reality the output is much lesser

Turbine Design:

The construction of the wind turbine starts from the design of the turbine. There are basically two types of designs which can be implemented: -

A. Horizontal Axis Wind Turbine (HAWT)

B. Vertical Axis Wind Turbine (VAWT)

An HAWT is the most commonly used because it is more efficient because the blades are always facing against the wind. This makes them to extract maximum power out of the wind but the drawback is that a tail has to be used so that it should be always in the wind's direction. Whereas in VAWT there is no need of a tail but the full power of wind is not utilized in this design it is more suggested for high wind speed applications. A wind turbine of 1 meter diameter is sufficient for this project. The blades have been made from normal PVC pipe. The generator is directly attached to the rotor. The generator used in this system is a simple permanent magnet DC motor. Since the wind speed at the area is less so, the RPM (Revolution per Minute) of turbine will be less and the motor chosen as a generator should have a low RPM. If motor used has high RPM rating then gears have to be attached to adjust the RPM between rotor and motor.

Charge Controller:

The charge controller is an electronic circuitry which monitors the solar and wind input and generates control for the charging. Charge controller works on electronic circuits and masters the system functioning. The charge controller is connected to both solar and wind inputs. It senses the voltage level from solar panel and wind generator. Then as per the algorithm defined it selects the suitable resource that is either solar PV or wind turbine to store the charge. The algorithm followed by the charge controller used in this system is as follows:

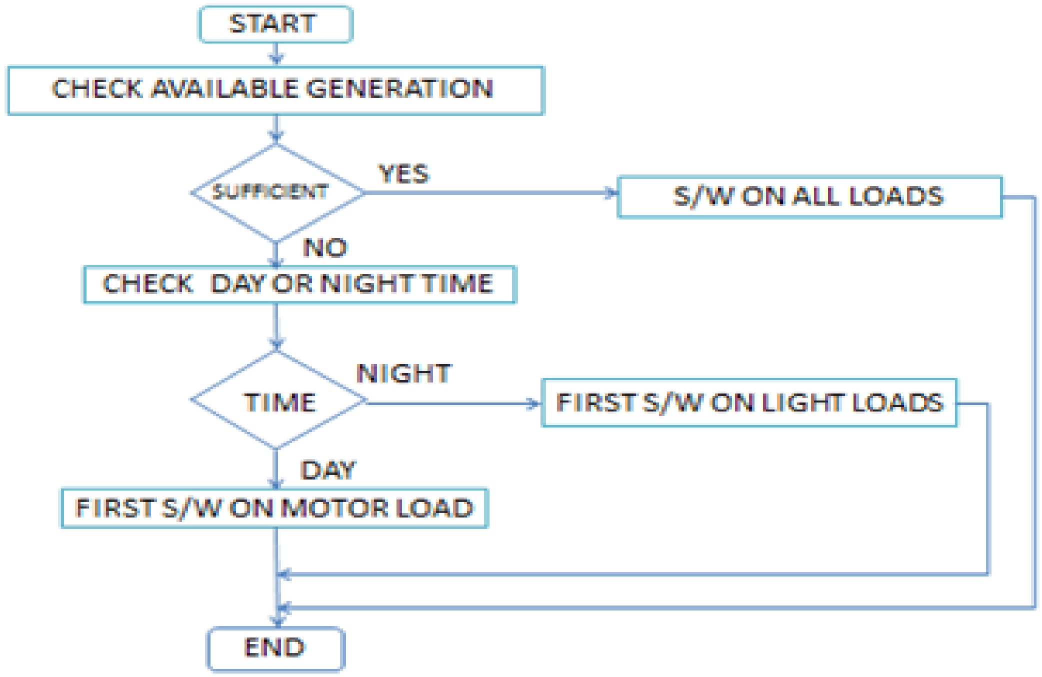

Fig 2 : Flow diagram of the controller algorithm

The algorithm aims at the solar panel output as the main input for the system as it is more dependable. The various switching operations are performed by the charge controller. The heart or brain of this system is the 8051 microcontroller. The microcontroller model used in this system is AT89C51 which is most commonly available microcontroller in the market. The reason for using 8051 is that it has each and everything available onboard which is required for this system and also for the future improvements in the system. Other thing is that it can be programmed easily with simple assembly language programming or C language program and is cheaper than other families of microcontrollers. The working of the microcontroller depends upon the input output signals provided to it by other connected circuitry. To sense the solar panel input voltage, a voltage sense circuit has been used. This circuit contains a zener diode and a grounded emitter npn transistor. The circuit diagram of this sense circuit has been illustrated below. The input from the solar panel is supplied to a resistor network comprising of two 10kohm resistors which divides the panel output and then feeds it to the zener diode. The zener diode has nominal zener voltage of 7.5volts. So, when the voltage at the zener diode exceeds 7.5 volts then the current flows through the diode to the transistor. As the gate voltage at the transistor increases the transistor goes to saturation mode. Then the voltage at the collector grounds through emitter and hence it provides a logic low to the microcontroller input pin. Pin P1.0 has been used to sense the solar panel output.

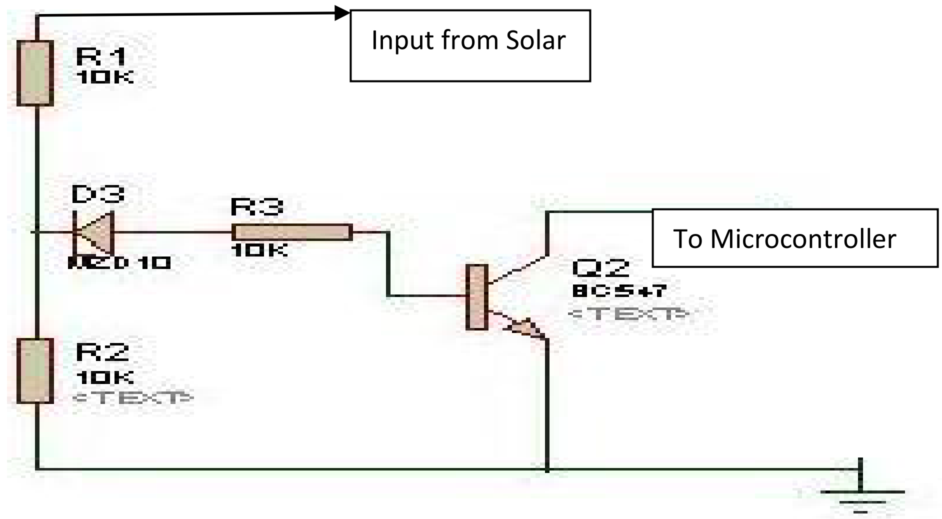

Fig3: Solar panel voltage sensor with grounded emitter transistor

The microcontroller senses for the logic low at P1.0 and sends a corresponding logic high signal to the pin which has been connected to the relay controller circuit. The relay controller circuit has been described below: -

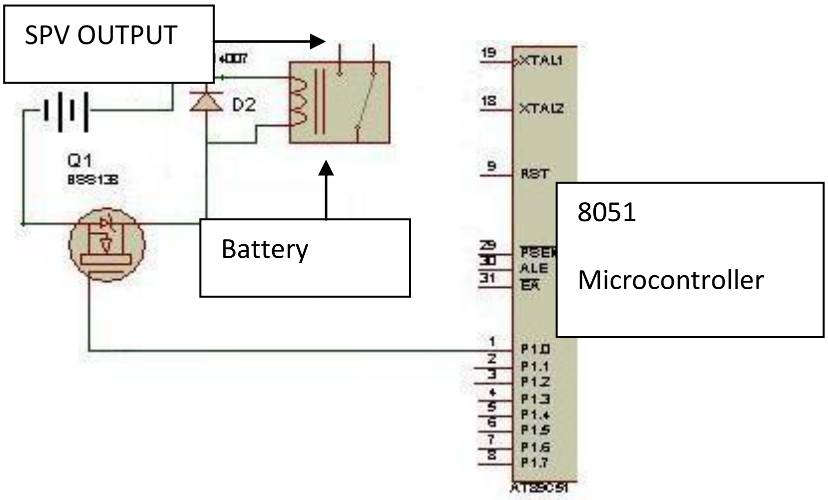

Fig4: Circuit to control the switching

The pin P1.1 has been connected to the gate terminal of the power MOSFET. The MOSFET used in this project is IRPF460. This is an n-channel MOSFET which is used for high power and high switching speed applications. When the gate voltage is applied to the MOSFET it operates in saturation region and the relay connected in series to the transistor energises and the panel output is connected to the battery. This will enable the charging of the battery. Before connecting the solar panel to the battery it is also required to check for the battery voltage if the battery is fully charged then we need not to connect it to the solar panel. The same circuit with some modification can also be used to sense for wind turbine output. To completely monitor the battery voltage with load supply control, an ADC has to be used. For serial input and parallel output ADC 0804 can be used. An LCD has also been used in this project to guide the user about various things happening inside the charge controller. The LCD used in this project has been used in 4-bit mode to save the pins of the microcontroller. In 4-bit mode only 6 pins of the microcontroller are required to be interfaced with the microcontroller. This LCD will have messages like ―Charging on‖, ―Battery full‖, ―Battery low‖ etc. LED's have also been used in the circuit to indicate common functions.

ADVANTAGES:

1) Optimization of energy usage

2) Reduction in operating costs

3) Increasing network reliability and visibility

4) Improved performance of existing infrastructure

5) Efficiency & life of system will increase.

6) Power management of RES in the energy sector.

7) Stress and failure of the system can be avoided.

DISADVANTAGES:

1) High initial Cost

2) Power generation is less

3) Depends upon environmental condition

APPLICATIONS:

- In Micro grid

3. CONCLUSION

The realized PMS, described in the paper, allows the reliable standalone operation of a kW-class residential microgrid fed by a controllable FC and a PV unit. It allows following both load and PV production variations by acting on the power control of the FC. The main objective of the PMS actions is the control of the battery state-of-charge, which is estimated by using an accurate algorithm developed for this purpose: this feature represents one key aspect of the developed system compared to existing ones, as it allows limiting in an effective way the number of startup and shutdown maneuvers of the FC. The estimation of the battery state-of-charge is also a crucial parameter for the management of the energy flows in a standalone. In manual mode also the switch can be used to turn ON and OFF the load.

We conclude from this project that hybrid power generation and management of hybrid power by using both automatic and manual methods.

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