



A Novel Power Management Strategy for a Grid-Connected System by PV-FC Hybrid System

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Abstract:

This paper deals with the power management strategy of grid connected photovoltaic and fuel cell hybrid system. Paper also presents the power management for grid connected output according to the PV system output. Here, the overall system consists of the hybrid PV and Fuel cell attached to the boost converter. The boost converter thus manages the final output voltage DC being fed to the inverter. Here, the DC to AC couples the controlled AC generated through the combination of both the modules and thus ties to the grid. Finally, the whole system is validating through MATLAB–Simulink environment.

Keywords: PV- FC Hybrid, grid, DC-DC Converters, power management, Fuel Cell, Inverter

I. INTRODUCTION

The system consists of a PV-FC hybrid sources with the main grid connecting to the boost converter and inverter. The energy in the hybrid system is balanced by boost converter to the inverter. On the other hand, fuel cell power generating system have been support to the PV generating so hybrid generation system consist of PV and fuel cell technogy are investigated for power generating. In this study, a grid connected fuel cell and PV power generating system was developed with Matlab Simulink .Solar module was developed based on solar model temperature and solar irradiation. Output current and voltage of PV system was used for input of boost converter and its output was used for the input of the inverter.

II. PHOTO-VOLTAIC (PV) POWER GENERATION

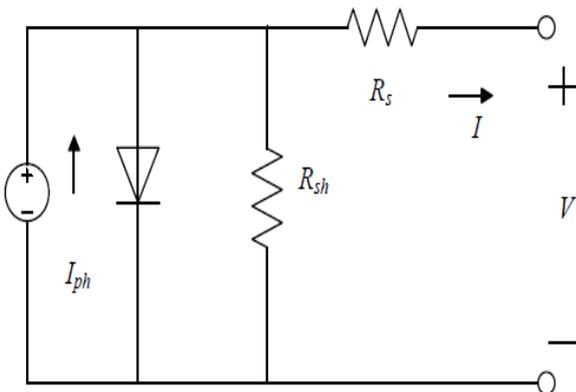


Figure.1. PV Circuit Model

Currently, solar energy generates power in following ways: photovoltaic, concentrated thermal power generation and photochemistry. Solar photovoltaic generation is based on the photovoltaic effect. Sunlight irradiating on PV panels is transformed into electrical energy directly.

It has advantages such as no emission, a long life, and the excellent applicability, etc. Its efficiency reaches 24.7%. Thus, PV generation becomes a widely used method. So we can get the mathematical model of PV panel from the model,

$$I = I_{ph} - I_{os} \times \exp \frac{q(V+IR_s)}{AkT} - 1 - \frac{V+I R_s}{R_{sh}} \text{----- (i)}$$

Where,

- I: the output current of PV cell (A)
- V: the output voltage of PV cell (V)
- I_{ph}: the output current of photo-generated current source
- I_{os}: the reverse saturation current of diode
- K: Boltzmann's constant
- Q: elementary charge
- T: PV battery working temperature (K)

III. BIDIRECTIONAL CONVERTER

In the microgrid, we often use a bidirectional converter to connect battery and grid. Since the output voltage of the battery is usually lower than the DC bus's voltage, so we use a boost converter from the battery to the DC bus, and a buck converter from DC bus to the battery,

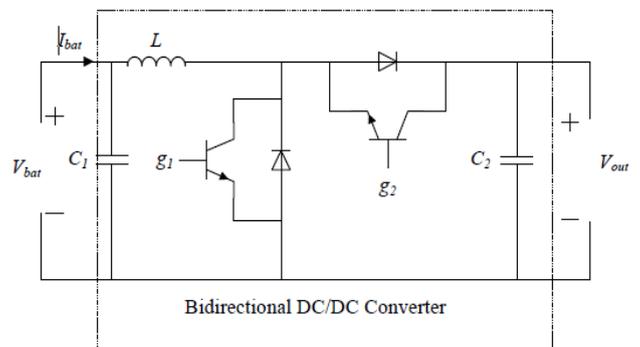


Figure.2. Bidirectional DC to DC Converter

When gate S1 has a signal 1 and gate S2 has a signal 0, this bidirectional converter works in boost mode, the power transmits from battery to the DC bus, and the battery operates in discharge mode. When gate S1 has a signal 0 and gate S2 has a signal 1, the bidirectional converter works in buck mode, power transmits from the DC bus to the battery, and the battery operates in charge mode.

IV. HYBRID POWER MANAGEMENT SYTEM

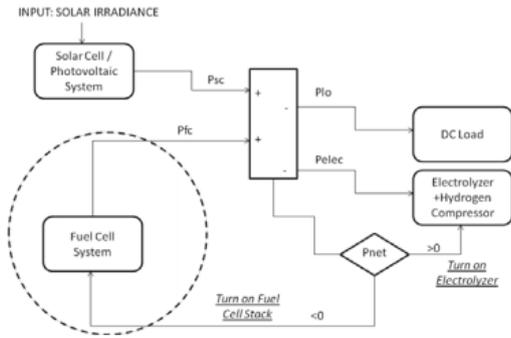


Figure.3. Power Management in grid tied power generation system

By increasing the use of renewable energy resources it is possible to support sustainable development of the global economy. Renewable energies include hydro 21 power, solid wastes, biomass, geothermal, solar thermal, solar photovoltaic, wind power, and fuel cell. The particular renewable energies that have shown progress and great potential for market penetration is photovoltaic (PV) and fuel cell. Therefore special kinds of power systems should be built to avoid shortages of power and to utilize all available energy from sun. There is an option to achieve it: power systems using two primary sources (solar cells and fuel cells) with an additional control scheme. This control scheme is well identified as a PMM implementation. In the scenario of alternative and sustainable energy, the governments of developed countries are working to explore the potential of some sources of energy such as hydrogen. Hundreds of studies also have demonstrated that Fuel Cells, which use hydrogen and oxygen to produce electrical power, represent an essential device for the future large-scale generation of electrical energy. Fuel Cells are useful as power sources in remote locations such as rural farms, military bases, wastewater treatment plants, hospitals, office buildings and many others.

V. PROPOSED MODEL

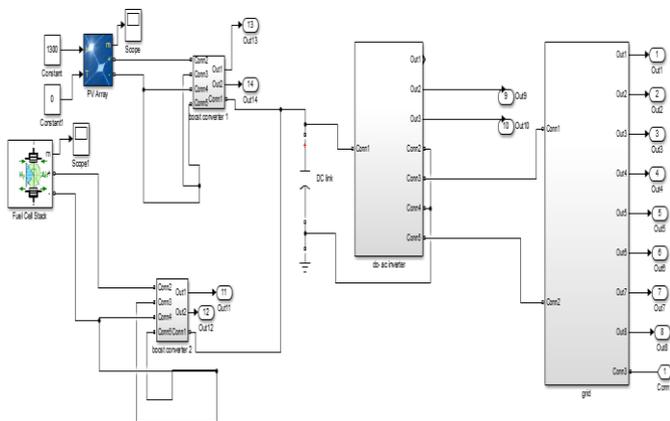


Figure.4. Overall SIMULINK model of the proposed system

Figure presents the overall model of the proposed model. In this model, the PV array and Fuel Cell Stack is connected to the boost converter that is the fed to the inverter. Here, the inverter converts the DC voltage generated by both the boost converters to the grid through the power coupling. In this case, the two sources such as PV and Fuel Cell is hybrid and thus used to perform the task of maintaining the final output power constant.

Fig. 5 shows the grid model of the proposed system. A microgrid is a localized grouping of electricity sources and loads that normally operate connected to and synchronous with the traditional centralized grid (macrogrid), but can disconnect and function autonomously as physical and/or economic conditions dictate.

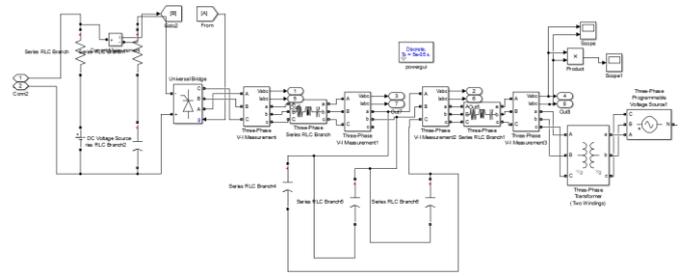


Figure.5. Simulink model of the grid model

VI. RESULTS & DISCUSSION

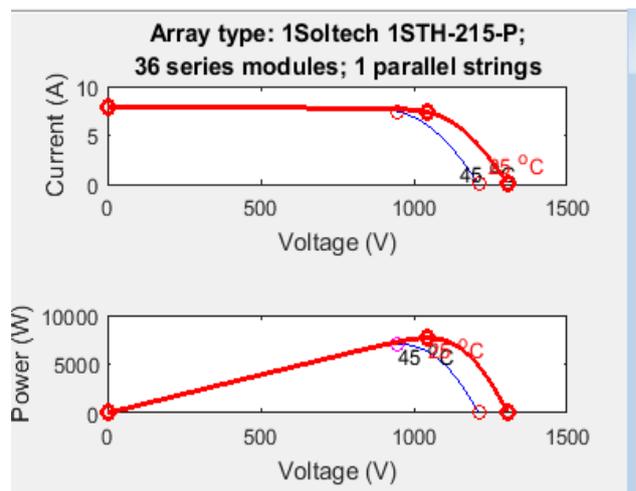


Figure.6. I-V Characteristics of PV

Figure 6 shows the I-V characteristics of the parallel strings of the PV array. The current characteristics are constant up to certain voltage. After it, falls down. Thus, the current of the PV array is constant with respect to the voltage. But, certainly depends on the temperature. Also, the power generated depends on the generated voltage. But, beyond certain voltage the power tends to fall as the current begins to drop.

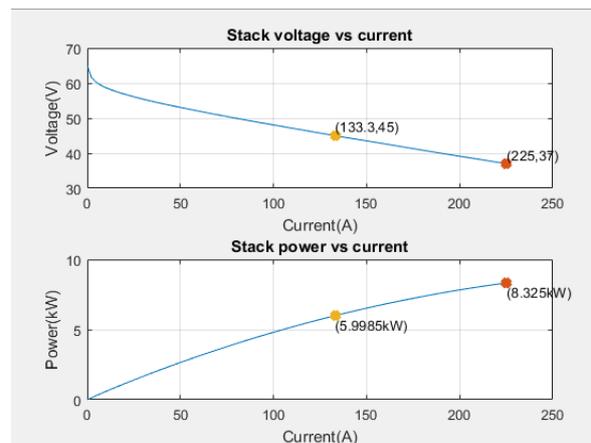


Figure.7. Voltage and Power Characteristics of Fuel Cell stack

In Figure 7, it shows that if we decrease the current density, the cell voltage and thus efficiency increase. But if we need to obtain a certain amount of power, the active cell area must

increase as the current density is decreased. We operate the cell at the left side of the power density peak and at a point that yields a good compromise of low operating point.

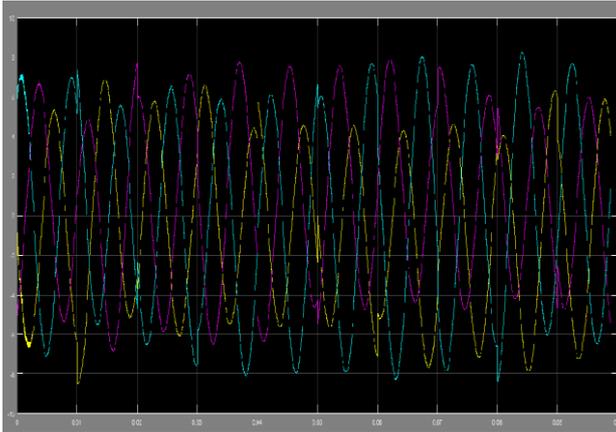


Figure. 8. Grid Three phase voltage output curve

Figure 8 represents the output voltage of the grid as the power is being managed by the hybrid PV-FC based generation. The three phase power has been managed by the PV-FC based power management. The boost converter and the inverter couples with that of the grid and thus has been maintaining the output voltage constant. Thus, this output curve validates the proposed model that the power has been managed in the PV-FC connected grid.

VII. CONCLUSION

This paper deals with the power management strategy of grid connected photovoltaic and fuel cell hybrid system. The system consists of a PV-FC hybrid sources with the main grid connecting to the boost converter and inverter. The energy in the hybrid system is balanced by boost converter to the inverter. On the other hand, fuel cell power generating system have been support to the PV generating so hybrid generation system consist of PV and fuel cell technology are investigated for power generating. Thus, using the simulation results, the power management for grid connected output according to the PV system and Fuel cell output has been validated. The power management and optimisation for the both utility has been shown through the graph. Finally, the whole system is validating through MATLAB–Simulink environment.

VIII. REFERENCES

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