MODELING AND OPERATION OF MICROGRID WITH WIND AND PHOTOVOLTAIC RESOURCES

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Abstract - *The interconnection of small modular devices such as photovoltaic, small wind turbines and storage devices ,commonly storage batteries to a Low Voltage distribution system leads to a new energy system known as the Microgrid. This paper presents the modeling and operation of microgrid with wind and photovoltaic resources. The study includes mathematical analysis and simulation of each nonconventional source, as well as their operation to a distribution grid. Part of this study is dedicated towards implementing a control strategy for the storage device, namely the controlling of charging and discharging of the storage device. The study also models various power conversions by use of power electronic devices. The microgrid is observed in with an dc-dc converter when the micro-energy source power, the local ac load , and the distribution grid power change.*

Key Words: Photovoltaic modules, Energy storage system, Wind power generation

1. INTRODUCTION

Microgrid enhances the integration of renewable and distributed energy sources, integration of combined power and heat ,reduces losses by locating generation near demand. A utility grid connection is used in order to replenish energy levels in the case of power shortage from the renewable energy sources. The combination of wind generator and PV modules with local energy storage devices may reduce exposure to natural disasters. Microgrids require defined Industrial costumer, substation, voltage, power factor with tolerances match load and generation. It also define loads, determine island duration, peak load, typical outage. Microgrid promotes demand side management and load leveling , ensuring energy supply for critical loads, reliability control. The microgrid is having reduced fuel consumption, having good efficiency.

Microgrids require defined microgrid boundary, Industrial customer, campus, substation, match load and generation, voltage, frequency and power factor within tolerances. The applications of Microgrids can vary in storage, advanced controls, size in Mega Watts , generation resource types, microgrid value proposition..The Microgrids gives Energy security, grid independence capability and ensure energy supply for critical loads utilizing on site generation.

Multiple input dc-dc converter is used for integrating into the main bus. The use of multiple input converters reduces use of additional parallel converters in each energy source. The wind/solar hybrid power system with an multiple input dc-dc converter in which the variations in the local ac load power and dispatch power to the distribution grid are considered. A direct driven permanent magnet synchronous

2. MODELLING OF MICROGRID

The below figure shows the sustainable microgrid system. A voltage level of 380V is considered to be the main dc bus voltage because it is suitable for bidirectional power flow between the power system and utility grid. A three-phase rectifier is used because the output voltage of wind generator is ac. The local ac distribution system is tied to a three phase 2.4kV distribution grid with a three-phase 240 V/ 2.4 kV transformer that reduces the harmonic content in the inverter output.

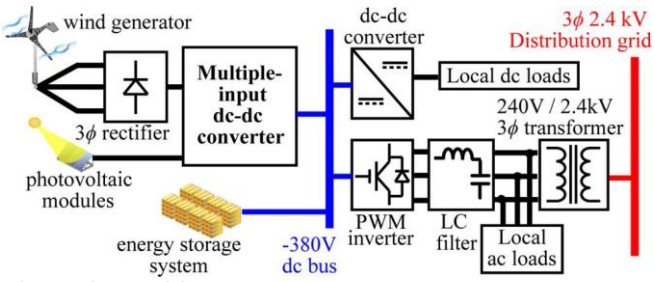

Fig 1 micro grid system

3.WIND TURBINE SYSTEM

Wind turbines work by turning the kinetic energy of the wind into torque (a force) that causes the wind turbine to turn and drives an electrical generator. The wind is made up of real matter with mass , when mass is moving it has kinetic energy. Wind turbine in this microgrid simulation study is modeled by an aerodynamic input torque which

drives a wind generator. The wind generator considered here is a gearless direct driven PMSG.

3.1 SIMULATION MODEL OF WIND TURBINE MODEL

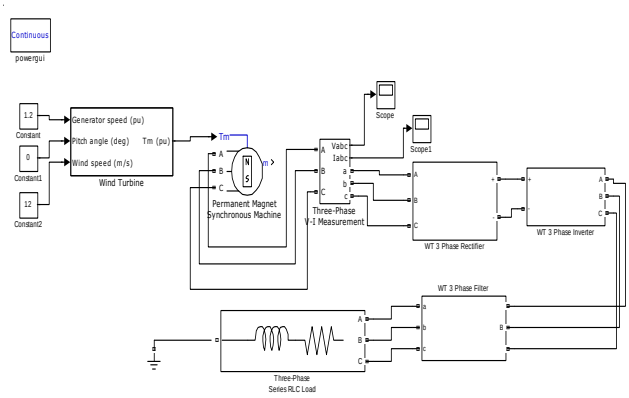

Fig 2-:Simulation model of wind turbine

4. PV SYSTEM MODEL

Photovoltaics is the method of converting solar energy into direct current electricity using semiconductor materials which exhibit photovoltaic effect PV model represent solar irradiance and temperature changes which may happen during the day. The PV system model is controlled so that it is operated at its MPP. Photo voltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. The materials used for photovoltaics include monocrystalline silicon, amorphous silicon. Photo voltaic power capacity is measured as maximum power output under standardized test conditions (STC) in Wp (Watts peak). The rated power system considered here is 10kw.

4.1 SIMULATION MODEL OF PV ARRAY

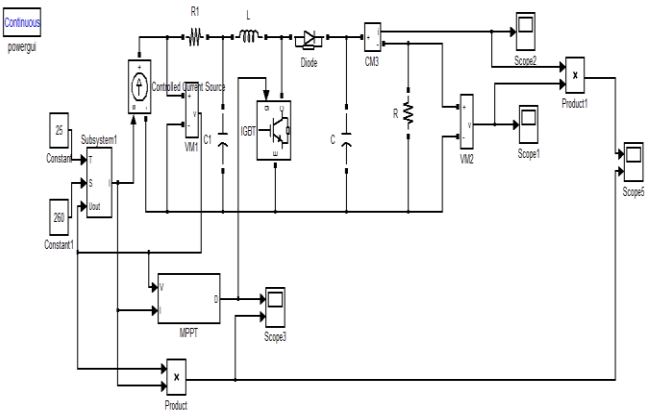

Fig 3-: Simulation model of PV module

5. ENERGY STORAGE SYSTEM(ESS)

A lithium-ion battery is a member of family of rechargeable battery types in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging.

5.1 SIMULATION MODEL

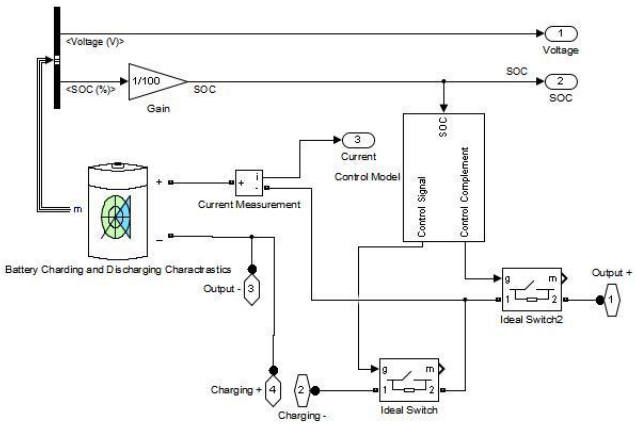

Fig 4- : Simulation model of battery

The parameters of the battery of storage capacity 20Ah, with a nominal voltage of 380 . added to the output of the converter to reduce output voltage ripple.

6. BUCK (STEP-DOWN) CONVERTER

It is a step down converter it reduces the voltage level. In this system the voltage level is stepped down from 380 V to
240 V .

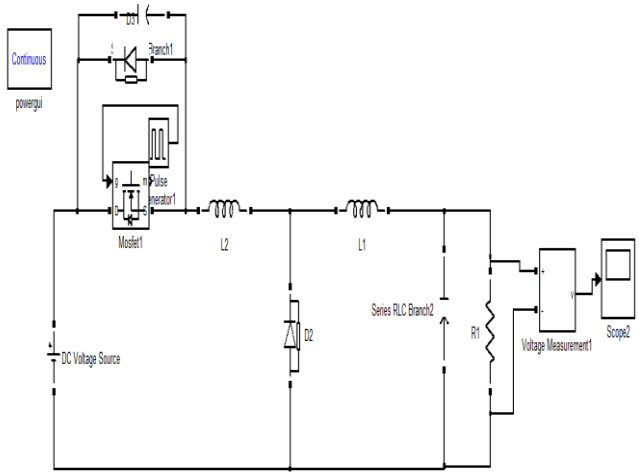

Fig 5- : Buck converter

6. MICRO GRID

The sources are integrated through a dc-dc converter. A 30kw wind/solar hybrid power system dynamic model is considered here.

6.1 SIMULATION MODEL

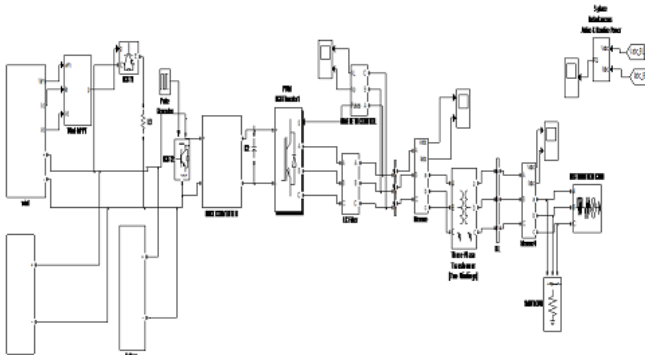

Fig 6-:Overall simulation diagram

7. RESULTS

7.1 SIMULATION RESULTS

The simulation results of the PV array module are

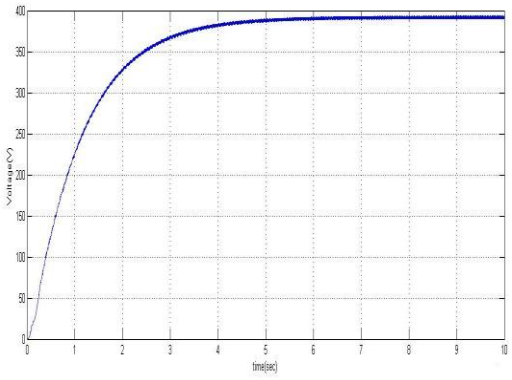

Fig 7-: PV array voltage

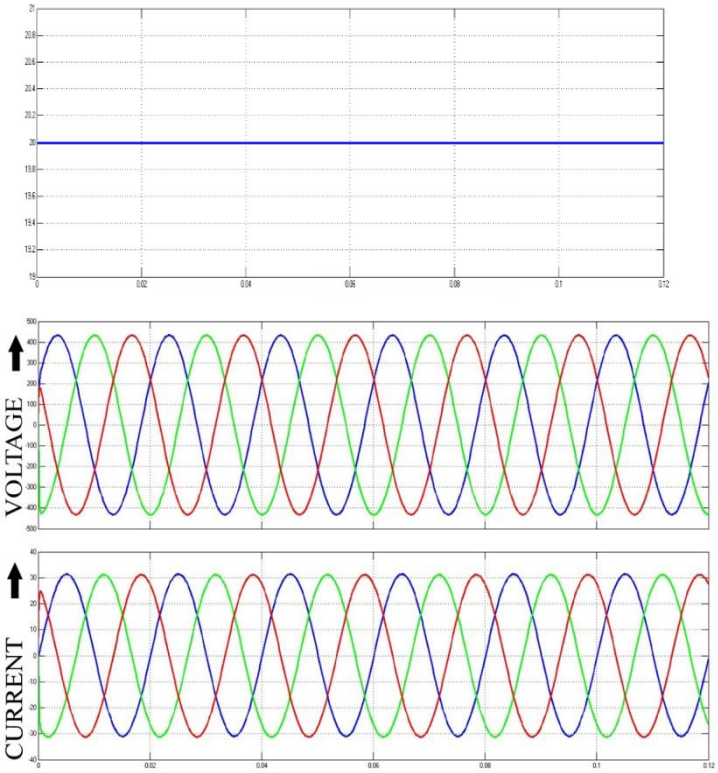

Fig 8-:Wind Turbine simulation results

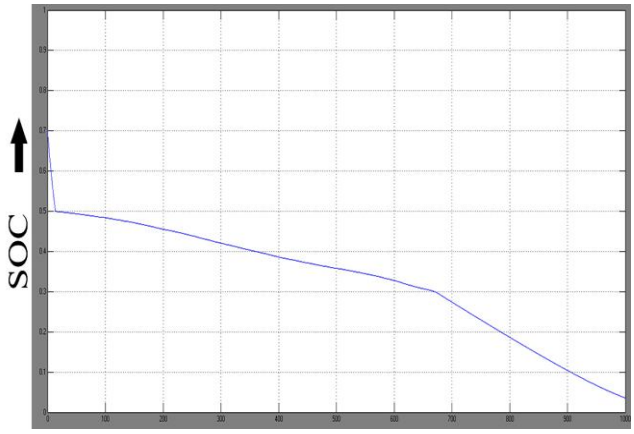

Fig 9-: Battery SOC output

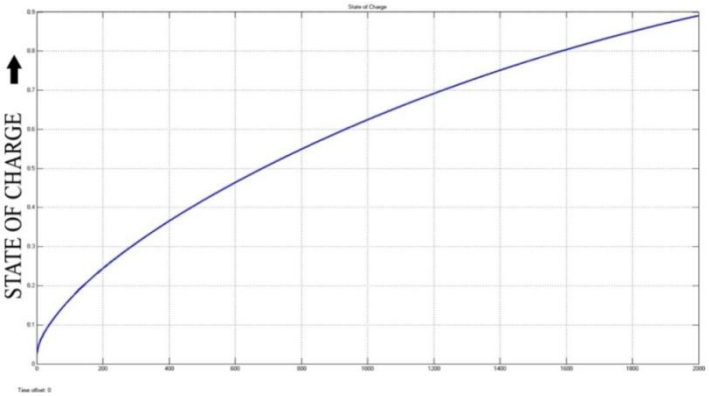

Fig 10-: Battery Charging characteristics

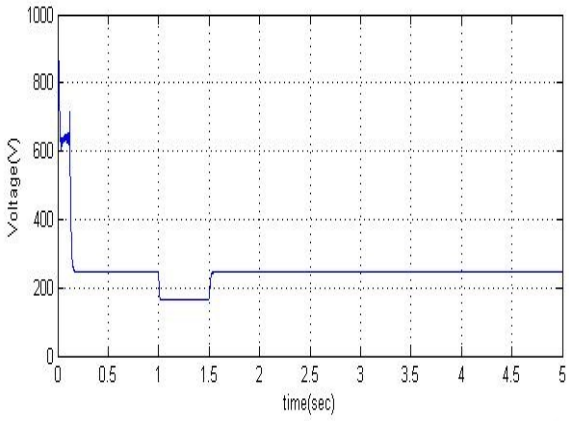

Fig 11-: AC load with battery characteristics

8. CONCLUSION

Modeling and operation of microgrid with wind and solar energy is analyzed in this paper. Rapidly changing irradiance and wind energy variations are considered in this paper. The considered microgrid is equipped with an energy storage system and is connected with distribution grid. Wind turbine, PV cell , storage system are considered in this paper. This paper is analysed mainly on the MPP tracking of the renewable micro-energy resources under variable dispatch power to the distribution grid. This paper explored the wide performance of the microgrid when the local ac load and dispatch power to the distribution grid change. The models included in this paper are PV cell, Wind schemes. A circuit based PV system model with an incremental conductance method is used for the simulation study

REFERENCES:

[1] A. Kwasinski and P. T. Krein, "Optimal configuration analysis of a microgrid- based telecom power system," in *Proc. IEEE 28th INTELEC*, 2006, pp. 1–8.
[2] S.-K. Kim, J.-H. Jeon, C.-H. Cho, J.-B. Ahn, and S.-H. Kwon, "Dynamic modelling and control of a grid-connected hybrid generation system with versatile power transfer," *IEEE Trans. Ind. Electron.*, vol. 55, no. 4, pp. 1677–1688, Apr. 2008. [3] P. M. Anderson and A. Bose, "Stability simulation of wind turbine systems," *IEEE Trans. Power Appl. Syst.*, vol. PAS-102, no. 12, pp. 3791–3795, Dec. 1983.
[4] M. G. Villalva, J. R. Gazoli, and E. R. Filho, "Comprehensive approach to modeling and simulation of photovoltaic arrays," *IEEE Trans. Power Electron.*, vol. 24, no. 5, pp. 1198–1208, May 2009.
[5] K. H. Hussein, I. Muta, T. Hoshino, and M. Osakada, "Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions," *Proc. IEE Generation, Transmiss., Distrib.*, vol. 142, no. 1, pp. 59–64, Jan.1995
[6] A. Kwasinski, "Quantitative evaluation of DC microgrids availability: Effects of system architecture and converter topology design choices," *IEEE Trans. Power Electron.*, vol. 26, no. 3, pp. 835–851, Mar. 2011.
7] A. Kwasinski and P. T. Krein, "A microgrid-based telecom power system using modular multiple-input DC-DC converters," in *Proc. IEEE 27th INTELEC*, 2005, pp. 515–520.
[8] C. Yaow-Ming, L. Yuan-Chuan, H. Shih-Chieh, and C. Chung-Sheng, "Multi-input inverter for grid-connected hybrid PV/Wind power system," *IEEE Trans. Power Electron.*, vol. 22, no. 3, pp. 1070–1077,May 2007.
[9] E. Muljadi and J. T. Bialasiewicz, "Hybrid power system with a controlled energy storage," in *Proc. IEEE 29th IECON*, 2003, vol. 2, pp. 1296–1301.

