Power Flow Management of Grid Connected Micro-grid

P Aruna Jeyanthy, Elstin Prees, K Saravanakumar

Abstract*: In this paper, a novel control method for the power flow management of grid connected with transformer-battery based system including bidirectional (BL) DC-DC converter is presented. The objective of this proposed system is to satisfy the load demand and control the power flow management from the different sources. A BL boost converter is used to boost the power from the wind and connected with battery charging or discharging. Rectifier is used here to convert AC to DC and that the received DC supply gets boost up by DC-DC boost converter. A BL converter is used for supplying loads. The advantage of the proposed work is simple in operation, minimizes the losses and feeds the extra amount of power into the grid. The battery can be charged from the grid also whenever it is required.

Keywords* : *DC micro grid, DC-DC converter, Energy storage system, Simulation.

I. INTRODUCTION

In this paper the development and control of the micro grid is done in simulink, in order to know the consequences in the real time applications. A prototype hardware model is also demonstrated representing the development and control of Micro-grid. The supply is taken from two sources namely energy storage battery and from the wind power. To do the simulink, the capacity of the wind power is taken from a 12V, 50amps transformer and is considered as fixed instead of the wind power effect. DC-DC BL converter is used here; if the grid didn't gets supply from the wind then the battery supplies the power to the grid with the help of DC-DC BL converter. This 12V transformer is Ac supply and it will be converted into DC with the help of rectifier. Battery storage capacity is also 12V. Thus the two sources used in the work are the 12V battery and 12V, 50Amps transformer. The Simulink details are given clearly in the following sections.

II. LITERATURE REVIEW

The increase in penetration of renewable energy has created challenges to the safe and reliable operation of micro-grid. Design of micro-grid system is done in matlab simulation, but no hardware part is done, because its cost is high [1-12]. In design and simulation of stand-alone micro-grid with energy storage system, they used solar and battery to supply grids [3]. In [2], wind, PV and battery hybrid system is used, by this more supplies can be obtained but the cost is high. In this proposed work prototype hardware demonstration and the simulation for the control of power flow management in micro-grid is presented. The architecture for the control of power flow management in grid connected micro-grid with energy storage battery is discussed below:

III. BLOCK DIAGRAM AND DESCRIPTION

The block diagram of the proposed work is given in the Fig. 1. The two sources are connected to the load through a DC micro grid. The working flow for the control of the power flow management is represented in the schematic diagram. In this working process 12V, 50amps transformer is used. Transformer is AC supply; this AC supply will be converted into DC with the help of Rectifier. This converted DC will be boosted by DC –DC Boost converter. By boosting the DC supply minimum 24V will be generated to the grid. Battery storage capacity is 12V. When there is no supply from transformer this 12V battery will give supply to grid. This 12V also will be boosted and grid will get 24V. By this we can satisfy the load demand

A. Transformer

Transformer is an electrical device that is used to raise or lower voltages (V) and currents (I). Transformers are used to boost voltages levels to decrease the line loses during transmission. Transformer is needed for efficient transmission of electricity.

B. Rectifier

Rectifier will convert AC i.e. alternating current to DC i.e. direct current. Here rectifier is needed because this project needs DC output from Transformer. Transformer is AC supply.

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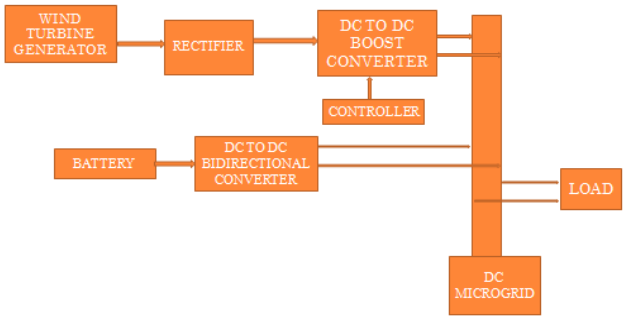

Fig. 1. Development and Control of Micro-grid

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C. DC to DC Boost Converter

Here the boost converter is a DC to DC converter with an output voltage greater than the source voltage. This converter will boost the 12V tapped from the transformer to the output voltage of minimum 24V to maximum 36V. As said the micro-grid, which is a small-scale power grid, here can operate independently or collaboratively. Also the received DC supply from both the sources will be given to grid, which will supply the load. In this work, the bidirectional DC-to-DC converter allows power flow in both forward and reverse directions.

IV. SIMULATION RESULTS AND DISCUSSIONS

The simulation work is carried on step by step procedure. Initially with the bidirectional converter, the micro grid works for the power flow management for the two generating sources namely the solar and the wind power source. The simulink diagram is represented in the below Fig. 2. The output for the given simulink in represented in Fig. 3. It shows the voltage and the current wave variation for the applied DC load.

The second step is carried out for the microgrid with the battery system, to deliver the continuous supply for the power flow management. The simulink schematic diagram is represented in Fig. 4. The output voltages for the complete system with the battery function is represented in Figure 5. As the wind power is variable in nature, the three phase ac power is represented in that figure.

Battery storage capacity is 12V. When there is no supply from transformer this 12V battery will give supply to grid. This 12V also will be boosted and grid will get 24V. By this we can satisfy the load demand. The simulink is done for the 12V battery boosted with the grid to get the output for 12V.

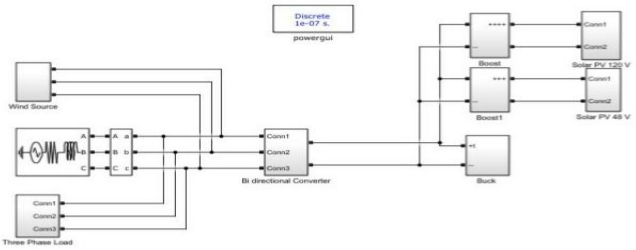

Fig. 2. Simulink diagram with the solar and wind power micro grid

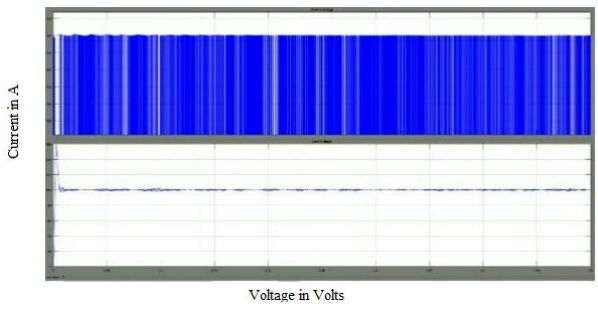

Fig. 3. Output voltage and current for the given DC load

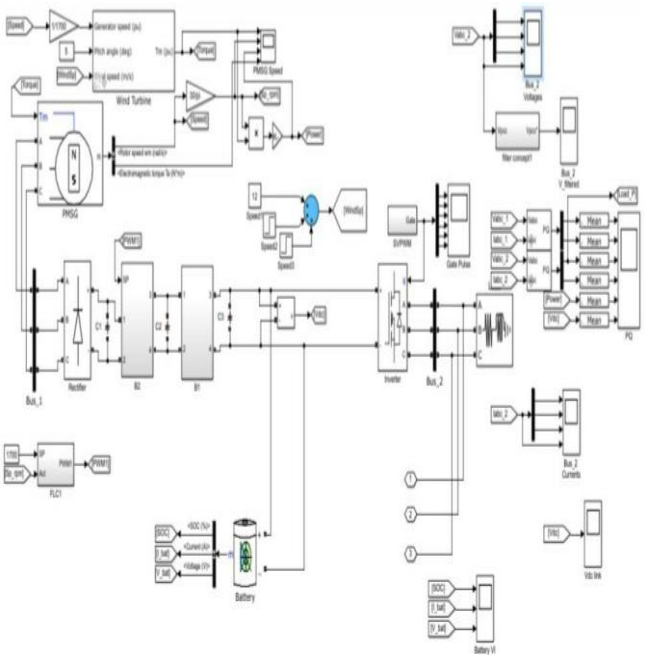

Fig. 4. Simulink diagram with battery system

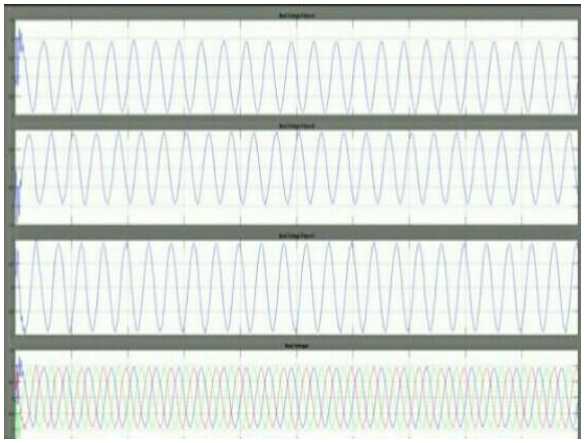

Fig. 5: Three phase output voltages from the wind turbine

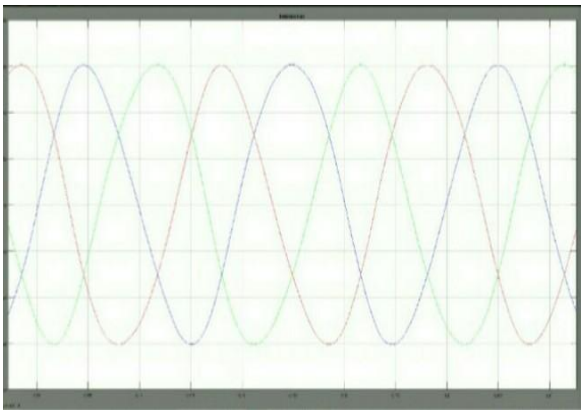

Fig. 6. Three phase reference current used by the Bidirectional Converter

V. HARDWARE IMPLEMENTATION

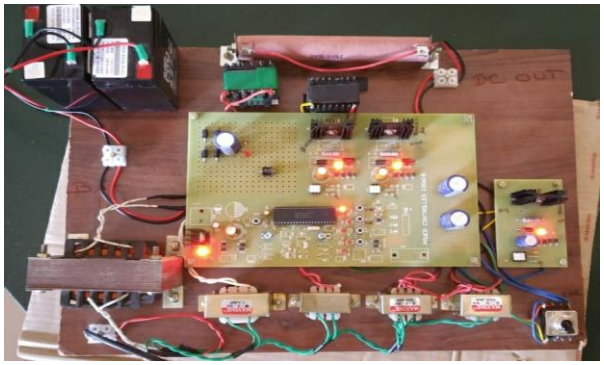

Fig. 7. Prototype of the proposed system

While charging mode the battery will get supply from 12V transformer, but this transformer will give 24V battery capacity is 12V so, we are using buck converter it will buck that 24V into 12V and supply to battery. In this method battery will be charged and grid will get supply from transformer. While discharging mode battery will give supply to grid, when there is no supply from transformer. Transformer will give 28V to grid and remaining will be given to battery, but battery will give all 30V to grid.

VI CONCLUSION

The development and control of a micro-grid is presented in this paper. Matlab simulink work is done to simulate the micro-grid. The work is also clearly demonstrated with a hardware setup for further processing.

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