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IMPACT OF ENERGY STROAGE ON HYBRID AC-DC MICRO-GRIDDURING PULSE LOAD

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ABSTRACT: ***Renewable energy based distributed generation plays an important role in electricity production. Electricity is consumed at the same time as it is generated. In this paper ,a hybrid AC-DC micro-grid is considered in islanding mode with solar energy; energy storage is proposed for integration of a pulse load. A synchronous generated is used to connect to the AC side. The AC and DC sides are linked through a bidirectional AC-DC inverter in order to control the power flow between AC and DC sides of the system. When a pulsed load is connected or disconnected on the AC side , the AC side voltage and frequency are maintained with in limits by the support of energy storage on DC . Simulation results show that the proposed micro-grid with control algorithms has maintained a balanced current and voltage profile there by improving the system reliability and stability.***

KEYWORDS: ***Energy storage, grid control, micro-grid, solar PV system voltage and frequency amplitude regulation, mat lab.***

I. INTRODUCTION

Now-a-days power system network has become more complex and it is has to provide secure, reliable and quality energy of supply to the communities. Reliability and stability of power system can be improved by introducing

the concept of micro-grid. Micro-grid is formed by integrating renewable energy sources into the distribution systems. Renewable energy based distributed generation plays an important role in electricity production. Electricity is consumed at the same time as it is generated. The amount of electricity must always be provided to meet the varying load demands. An imbalance between supply and demand will damage the stability and quality of the power supply even when it does not lead to unsatisfied demand. Renewable energy such as solar, have some drawbacks like renewable energy load intermittencies and load mismatches. In order to by-pass these constraints, the concept of photovoltaic systems integrated with an energy storage to match the supply and demand of energy is essential for large and small scale applications. In this paper, a hybrid AC_DC micro-grid with solar energy, energy storage and(battery), and a pulse load is proposed. By utilizing sustainable energy and influencing pulse load, the micro-grid can be viewed as a PEV parking garage power system or a ships power system. Solar panel connected to the AC bus through boost converter and battery banks inject or absorb energy on DC bus to regulate the DC side voltage. The frequency and voltage of the AC side are regulated by a directional AC-DC inverter. The power control of these devices serves to increase the system stability and reliability. This paper is organised as follows: single line diagram of micro-grid system and its components are presented in section II. Coordinated control of converter in islanding mode is presented in section III. Section IV demonstrates the simulation results that verify the proposed topology and control method that increase the system stability under the influence of a pulse load. Finally conclusions are drawing in section.

II. SINGLE LINE DIAGRAM OF MICRO-GRID SYSTEM AND ITS COMPONENTS

Represents the hybrid Micro-grid configuration where various AC,DC sources and loads are connected to corresponding AC and DC networks. The AC and DC sides are linked through a bidirectional three phase AC-DC inverter and transformer. The various characteristics and the component used in the hybrid Micro-grid system are depending on the application.

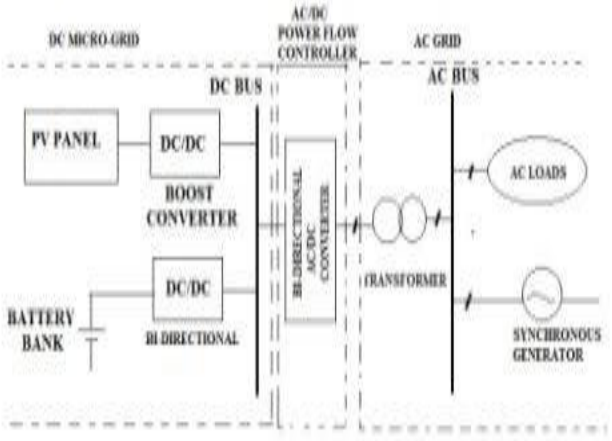
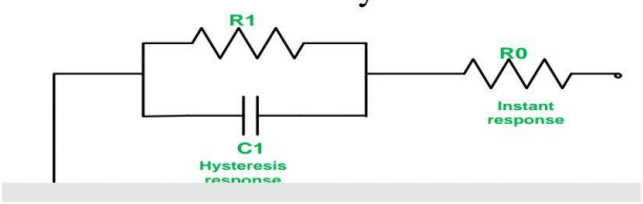


Figure 1: hybrid ac-dc Micro-grid power system.

2.1 MODELING OF LITHIUM –ION BATTERY BANK

An accurate battery cell model is needed to regulate the DC bus voltage in islanding mode. The battery terminal voltage and SOC need to be estimated during operation. A high Fidelity electrical model of lithium –ion battery model with Thermal dependence is used. The equivalent circuit of the battery shown in figure



2.2. MODELING OF PV MODEL

Figure 3 shows the equivalent circuit of PV panel equations (2)-(7) shows mathematical equations of PV panel and its output current all the parameters are shown in table 1

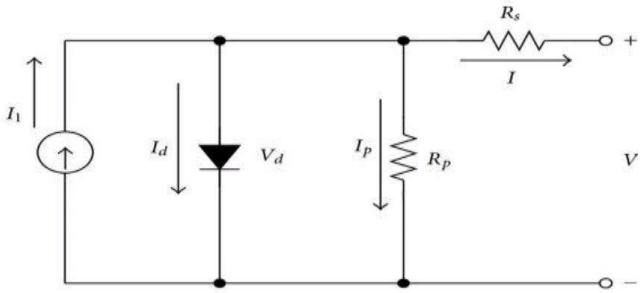


Figure 3: Equivalent PV panel.

Table 1:Parameters for photovoltaic cell.

Symbol	Description	Value
V_{oc}	Rated open circuit voltage	64.2V
I_{ph}	Photocurrent	5.9602 A
I_{sat}	Module reverse saturation current	$1.1753*10^{-8}$
Q	Electron charge	$1.602*10^{-19}$ C
A	Ideality factor	1.50

III. COORDINATED CONTROL OF CONVERTER

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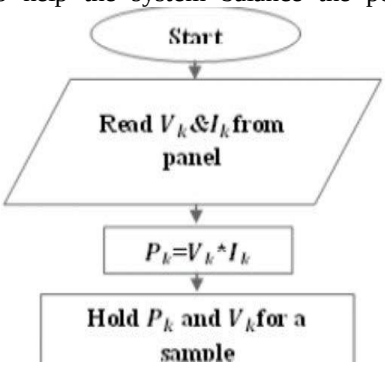
Three types of converters are utilized in this proposed hybrid micro grid .These converters must be actively controlled in order to supply uninterrupted power with high efficiency and quality to critical loads on the AC and DC sides during islanding mode. The control method for the converters is discussed in this section.

3.1 . BOOST CONVERTER CONTROL WITH MPPT

In islanding mode ,the boost converter of the PV form operates in on- MPPT or off –MPPT which is based on the systems power balance and the SOCs of the battery banks. In most situations ,this boost converter can operate in the on- MPPT mode since the variation of the solar irradiance is much slower compared with the power adjustment ability of the AC generator. Therefore ,for given load either on the AC or DC side, the PV should supply as much power as possible to maximum output power is larger than the total load in the hybrid micro grid, the PV should be turned to off – MPPT to help the system balance the power flow.



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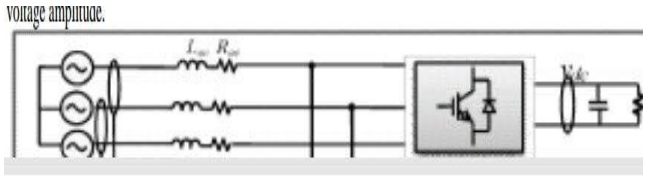
The outer voltage controlled loop is used to generate a reference charging current controlled loop. The error between the measured DC bus voltage and the system reference DC bus voltage is set as the input of the PI controller, and the output is the reference current. The inner current control loop will compare the reference current signal with the measured current flow through the converter and finally generate a PWM signal to drive the IGBT STD or ST c to regulate the current flow in the converter. For example, when the DC bus voltage is higher than the reference voltage, the outer voltage controller will generate a negative current reference signal, and the inner current control loop will adjust the duty cycle to force the current flow from the DC bus to the battery, which results in charging of the battery. The energy transfer from DC bus to the battery and the DC bus voltage will decrease to the normal value. If the DC bus voltage is lower than the normal value, the outer voltage control loop will generated a positive current reference signal, which will regulate the current flow from the battery to the DC bus, and because of the extra energy injected from the batteries, the DC bus voltage will increase to the normal value.

3.3 . BI-DIRECTONAL AC-DC INVERTOR CONTROL

The frequency and voltage amplitude of the three phase AC side is not fixed during islanding operation so a device is needed to regulate these variables. A bi-directional AC-DC inverter is used with the active and reactive power decoupling technique to keep the AC side stable. The control scheme for the bi-directional AC-DC inverter is shown in Fig. 8. In d-q co-ordinates, Id is controlled to regulate the active power flow through the inverter to regulate the AC side frequency, and I q is controlled to regulate the active power flow through the inverter to regulate the AC side voltage amplitude.



IV. SYSTEM SIMULATION RESULTS

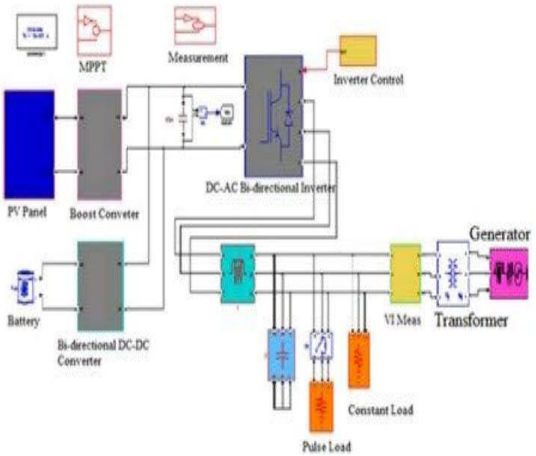


Fig 7: MATLAB /SIMULINK of hybrid AC-DC Micro-Grid with solar energy, energy storage and critical load.

The operation of the hybrid micro grid utilizing a 10.07kw PV farm under the influence of a 10kw pulse load is simulated to verify the proposed control algorithms. The rated output of the synchronous generator is 13.8kw, and a 4kw constant load is connected in the AC side. Five 51.8v 21Ah Lithium – ion battery banks are connected individually to the DC bus through bidirectional DC-DC converters. The system parameters for the Micro- grid are listed in table II.

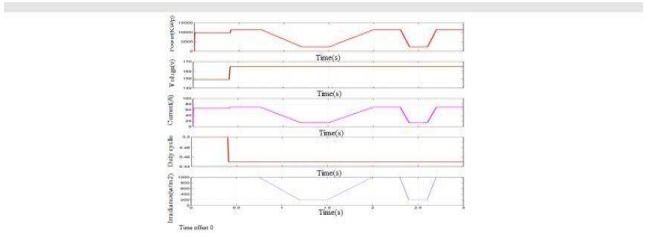
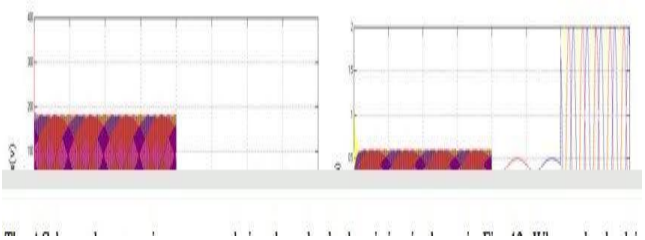


Figure 8: PV farm output power control with MPPT.

Fig.9 represents AC bus voltage with pulse load interference. When t=2s the pulse load is connected to the system, before 2s generation in the AC side delivers to the system but when pulse load is connected to the system, the generation in the AC side is not sufficient to the total load so as t=2.2s, the system collapsed, and voltage dropped considerably. The system couldn,t recover even after the pulse load was disconnected after t=3s.The



The AC bus voltage transient response during the pulse load variation is shown in fig.12. When pulse load is connected and disconnected for a particular time intervals to the system, the ac voltage amplitude returned to its normal value in less than three cycles.

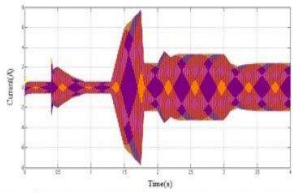
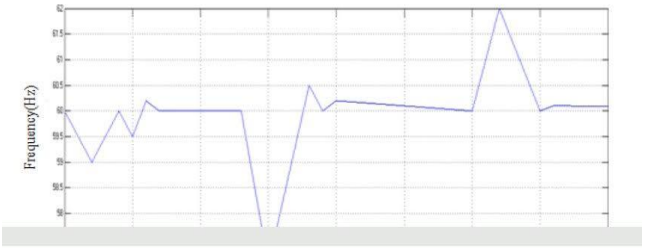


Figure 13: AC side current with AC pulse load influence.

Figure13 shows AC side current with pulse load influence. When the pulse load is connected to the AC side, the current flow through the AC bus increased immediately, and after the pulse load disconnected from the AC side, the current slightly decreased to keep the system in balanced.



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