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Fuzzy Logic based Battery Energy Storage System (Bess) for the Improvement in Stability of an Islanded Micro-Grid

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Abstract--- In this paper, the dynamic power and the responsive control of power of a (BESS) Battery energy storage system using the fuzzy logic control to keep up recurrence & the constancy of voltage of the Islanded Micro-grid. In the primary extent of the introduced paper is to consider the adequacy of the Battery energy storage system controller in perspective on fluctuations of recurrence/voltage exposed to an aggravation happening in the islanded micro-grid. In the islanded micro-grid framework, the power is created from sustainable power source assets (RESs), i.e., sun & hydro based PV. The utilization of these spotless vitality sources has turned into the principle issue, visualizing the yield control vulnerabilities from renewable energy sources. Further, power vulnerability elevates control quality issues and prompts control disappointment. To beat such issues, the proposed fuzzy logic controller (FLC) approach is connected to BESS controller to advance the stability of the islanded Micro-grid. The simulation result represents that both the control approaches permit the dynamic dependability of the micro-grid and the maintenance of recurrence and the voltage inside satisfactory reaches. Therefore, the proposed BESS fuzzy logic control is not as much prone to vulnerability than the BESS robust control.

I. INTRODUCTION

For quite a few years, the use of sustainable power source assets (RESs), for example, wind, solar, and biomass energy, rather than non-renewable energy source assets has obtained more consideration around the world because of the expanding awareness's with respect to issues concerning an unnatural weather change. However, Renewable Energy sources have significantly made dis-continuity in power exchange, which influences the stability, efficiency, reliability and power quality of power system. Consequently, the idea of micro-grid is regarded as a conceivable answer for the arrangement with these issues. The micro-grid is made out of many little power bases & energy storage system (ESSs), recognized as distributed-energy resources (DERs) to supply power to the neighbouring load regions. DERs are associated with micro-grid over power electronic gadgets, for example, power-inverters. The micro-grid can work by associating with the main-grid, which is very well known as the grid-connected mode, or operates autonomously when any type of disturbances and fault happens in the main-grid, which is recognized as islanded-mode.

In the grid-connected approach, power storage is normally on pivoting multitudes of the synchronous-generators in the main-grid. At the point when the aggravations happen in the main-grid, the micro-grid can rapidly react to the changes. Accordingly, the micro-grid can keep up the stability of voltage/recurrence. Hence, in this system, the power inside the micro-grid is adjusted by the main-grid. In an islanded mode, the DERs are fundamentally in charge of keeping up the recurrence/voltage strength inside the micro-grid. However, the conduct of the micro-grid in this mode demonstrates less idleness qualities, in light of the fact that numerous gadgets are associated with the micro-grid by means of the inverters. Thus, the DERs gives a moderate reply to deviations which may cause imbalance in power and which results to voltage and recurrence unsteadiness in the micro-grid. This process is a test for the management of energy in the micro-grid. To take care of this issue, numerous analysts have shown their interest in the establishment of Energy conserving system in the micro-grid to give the recurrence and voltage strength and to keep up parity of the dynamic and responsive forces. In any case, the connected ESS ought to have a quick reaction to the unsettling influences happening in the micro-grid. Henceforth, the quick charge and the discharge rate control technique for the Energy storage system has been significant and should be considered. A few control strategies are applied for the Energy storage system controller. Each control strategy requires scientific designs for the investigation to plan the Energy storage system controllers, for example, a corresponding indispensable (PI) control or proportional-integer control. This control is the mostly applied technique since it is easy to utilize and gives acceptable execution. Though, the operation of the PI controller is tarnished after the working state of the functioning ailment of the framework changes. Thus, the robust method has been an alternative to remove this problem. It effectively operates the working states of the framework & empowers a quick reaction to the unsettling influences which happen. Thus, the Energy storage system controller can rapidly react to convey the dynamic & receptive powers and lessen recurrence & voltage deviations of the framework.

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Thus, the methodology is popular to use for, single-output, single-input (SOSI) framework since a SOSI framework can be easily analysed by numerical model. On account of such confinements, the FLC technique is other choice that is useful for the ESS controllers design. This technique examines framework from the learning and knowledge of the master. It doesn't have to linearize the framework to be a scientific model. Subsequently, this strategy is reasonable for complicated, dubious, SOSI and multi-output, multi-input (MOMI) frameworks. The Energy storage system technologies are further divided into four categories. The Operating principles, qualities, and features of each kind are shown and comparison is done in aspects of rating, response and yield duration, lifespan, efficiency, and operating charges. As of late, BESSs have turned out to be a standout amongst the most prevalent ESS advancements. Thus this paper focuses on the stabilisation problem of islanded micro-grid system.

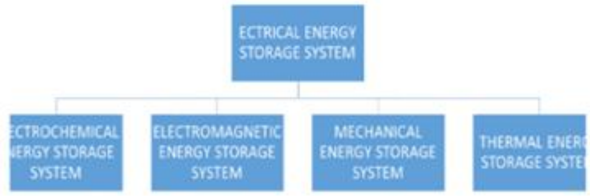

Fig. 1: Classification of Energy Storage System

II. MICRO-GRID

The micro-grid is a solitary, managing, self-sufficient control framework, that comprises of distribution generation (DG), ESSs, controlling gadgets to which the Distribution Generation & Energy storage system are directly connected to the required side. The micro-grid can operate either an islanded mode or grid-connected mode. The configured details of the framework are exhibited in fig 2.

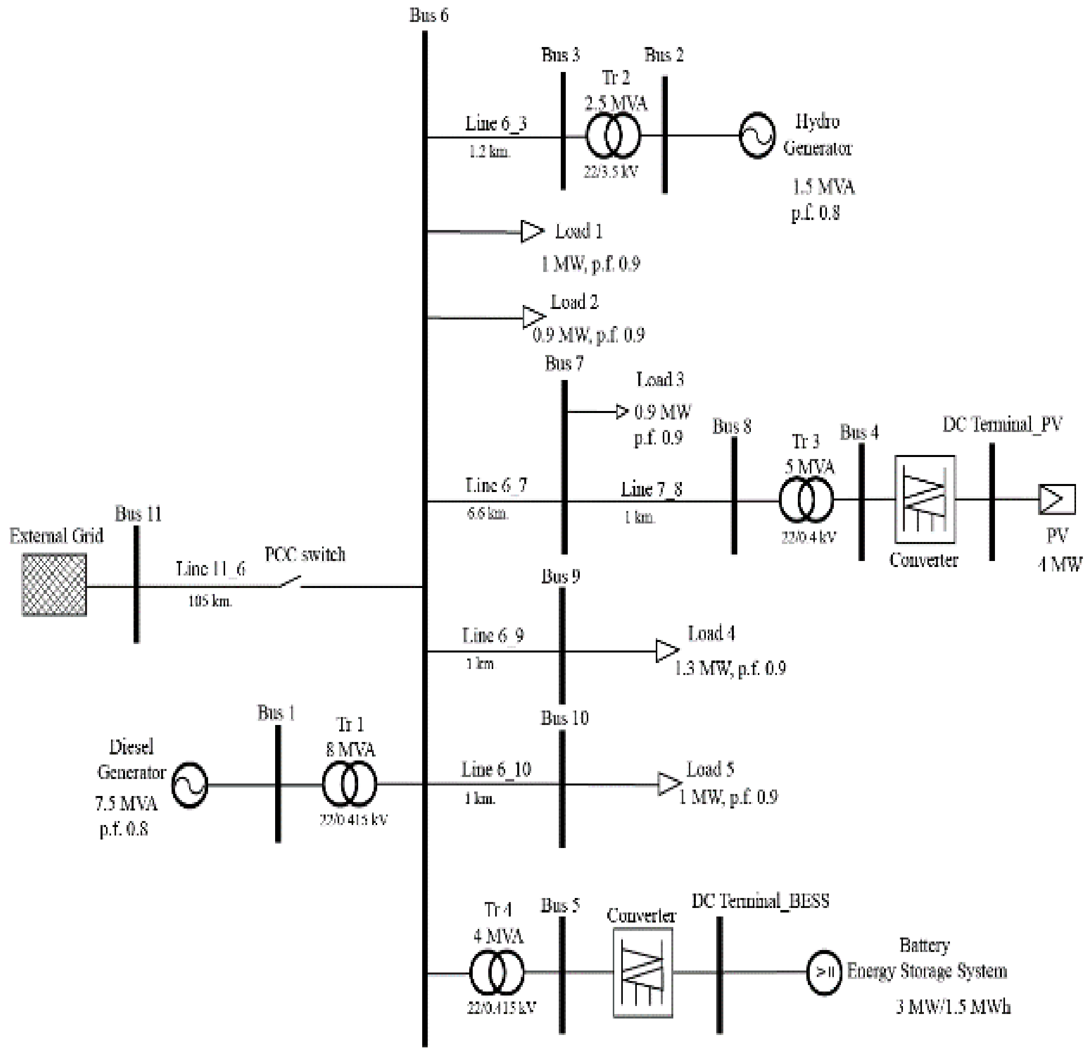

Fig. 2: Micro Grid Unit

A micro-grid is a self-sufficient single PS, which constitutes of several distribution generation (DGs) units, Energy storage system, controlling devices and loads. The modelling of micro-grid is described further.

Battery Energy Storage System modelling

The BESSs has been developed by various different approaches.

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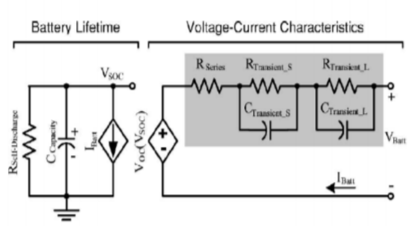

Fig.3: BESS Model

The above BESSs model in figure 3 was proposed by Chen and Rincon-Mora and was chosen because of its precision and simplicity.

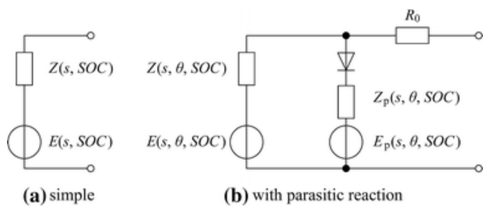

Fig. 4: Electric Battery Design

Figure 3 represents a simple electric battery design (a) and a complex form battery design (b).

A battery energy storage system (BESSs) has to represent several key behaviours i.e. voltage, current, capacity, state of charge, impedance and losses. The proposed BESSs circuit diagram is given below.

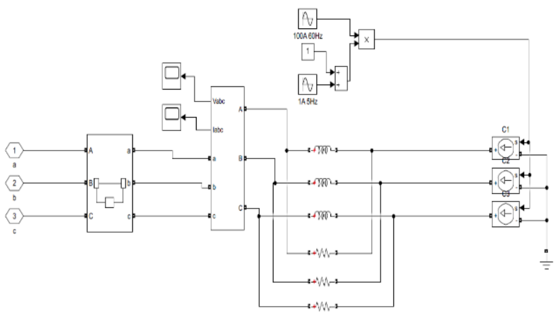

Fig. 5: Circuit of BESS

Isolated DG modelling

Dispatchable distributed generation implies to the sources or areas of production of power which can be provided at the request of power operators or request from the owner of a plant according to public needs. It can be switched on or off, and can adjust their power outcome according to an order. E.g. Micro Turbines.

A synchronous generator framework is shown in fig:6, a power system stabilizer (PSS) and an automation voltage regulator (AVR) are equipped for the excitation system control.

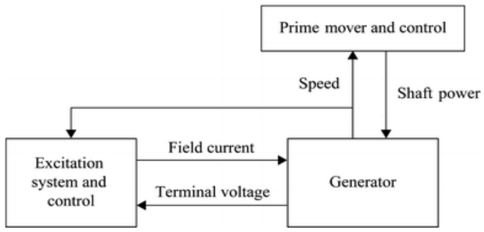

Fig. 6: Power system stabilizer

Operating Modes of Micro-grid

The micro-grid in a grid associated means is connected to exchange the Powers i.e. dynamic power and responsive powers with the main-grid by means of the switch at the mutual connection area. At the point when the unsettling influence happens in the system, the micro-grid gets transferred to islanded method through grid connected method. In this manner, the Dispatchable generation and Battery stockpiling framework in the micro-grid will consequently feeds power to the neighbouring loads. If the other functioning means isn't effective, the micro-grid will turn into the shutdown mode due to which power outage takes place. Later, the micro-grid will continue activity when main- grid comes back to the typical state (grid connected mode).

Figure 7 shows the operation of micro-grid.

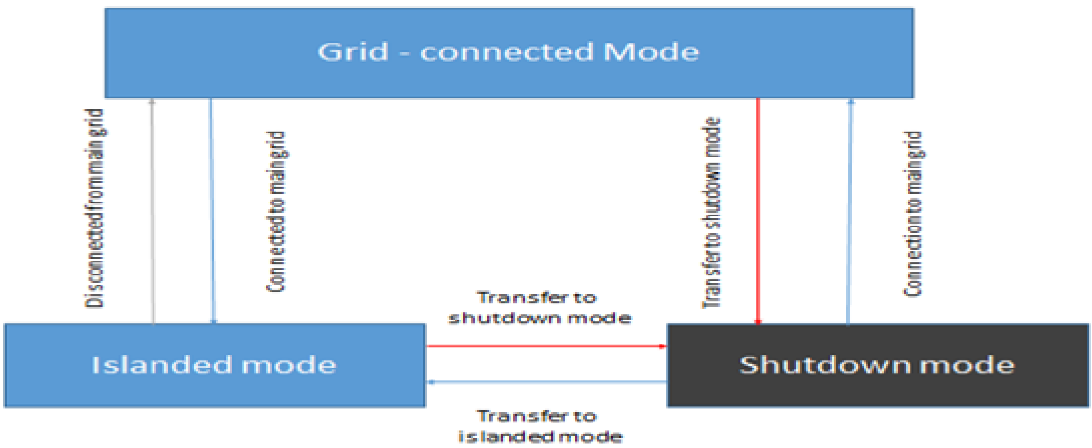

Fig. 7: Micro- Grid Operation

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III. BESSS CONTROL METHOD

The BESS controlling technique is an important area of this study. It constitutes of the dynamic power controller (p controller) & the responsive controller of BESS (Q Controller). The dynamic power & responsive power signal is transferred to the loop of p controller and q controller respectively. Further, the o/p signal is transferred to converter & is then directed back to the micro-grid to lessen the unconventionalities due to recurrence and voltage. The deviations and fluctuations can be removed by the stable control between power demand and the power supply through BESS control.

For ages, the FLC technique is used worldwide. Its major contribution is in area of control system as it is considered as a highly reliable control technique. Its framework is shown below in figure 8.

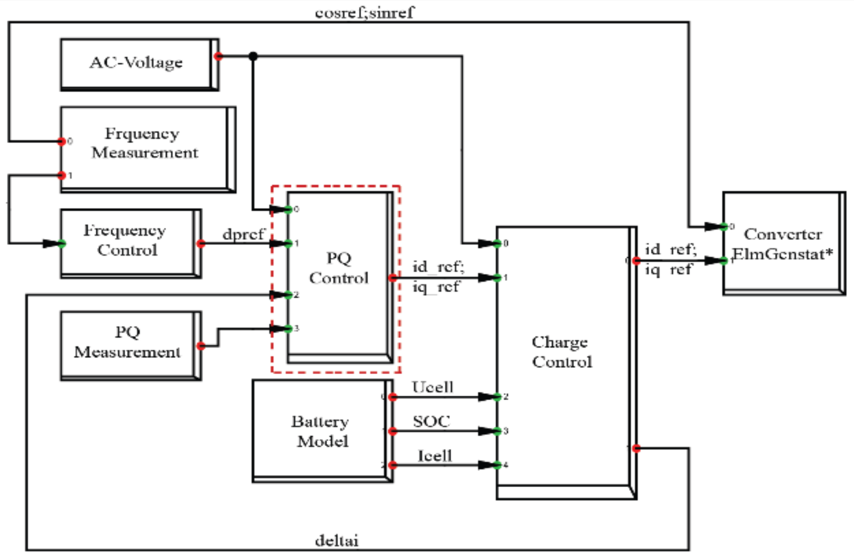

Fig. 8: Model of BESS-Controller

A. Fuzzy logic control (establishment)

The FLC technique is connected with the Battery energy storage controller to keep up recurrence and voltage stable form inside the desired micro-grid operation requirement.
The BESSs fuzzy logic controller has been demonstrated below.

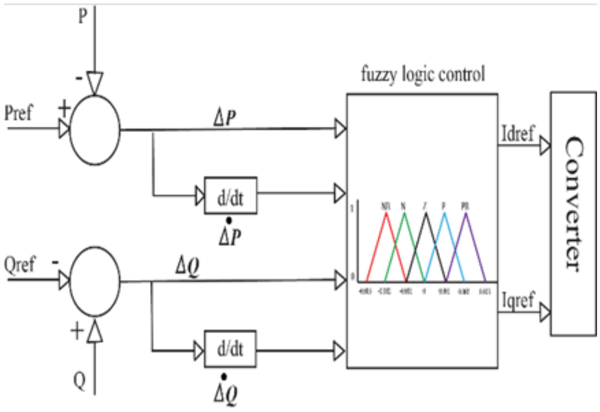

Fig. 9: Fuzzy Logic Controller

Here ΔP is the fault and ΔQ is the battery energy storage dynamic power deviation of the fault being the input signal Iq(ref) is the output signal of controller P. Thus these 2 inputs are further categorized as input triangular functions i.e. NB (negative big), P (Positive), PB (Positive big), Z (Zero), and N (Negative).

The controlling instructions are as follows:

If ΔP is NB and ΔQ is PB then Iq (ref) should be zero i.e. Zero.

If ΔP is fault and ΔQ is the change of fault of BESSs of the chosen responsive power to be the input signal

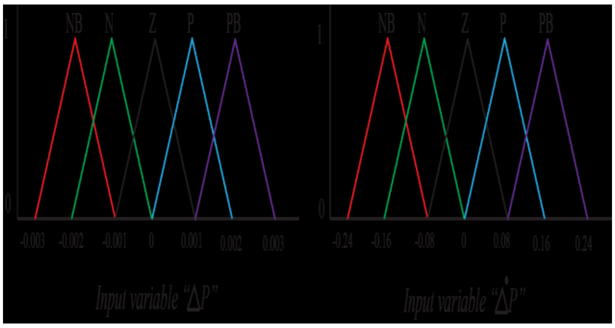

Fig.10: Membership function plot of Q controller

B. Robust control (Establishment)

To test efficiency of BESS FLC technique, the robust control method (BESS) too is aimed for recurrence/ voltage stability & for the improvement in the dynamic reply of the islanded micro-grid. The procedure is executed by the subsequent steps:

Formulation of the micro-grid model

By creating mathematical model for studied micro grid framework, to make a robust BESS controller.

IV. SIMULATION CIRCUIT DIAGRAM

The Simulated circuit consists of various controlled and operating system, which includes PV panel, controlled sources, measurement inputs and Battery to store energy.

DC link is used to convert power system in to DC with the help of rectifier to minimise the disturbances. DC link consists of capacitor to filter out AC waveform to get straight line DC waveform.

DC link of power conversion equipment is the output of rectifier section coupled with capacitor.

Maximum Power Point Tracker (MPPT) is used with the PV panel to optimise the output to get higher efficiency. It is basically used to track high intensity of light to optimise output by following sun light. It increases the output by 15% during winters and about 35% during summers.

We have used Fuzzy logic controller (shown in simulation circuit fig.13) because it is cheaper, robust, customised, efficient, reliable, and designed to emulate human deductive thinking

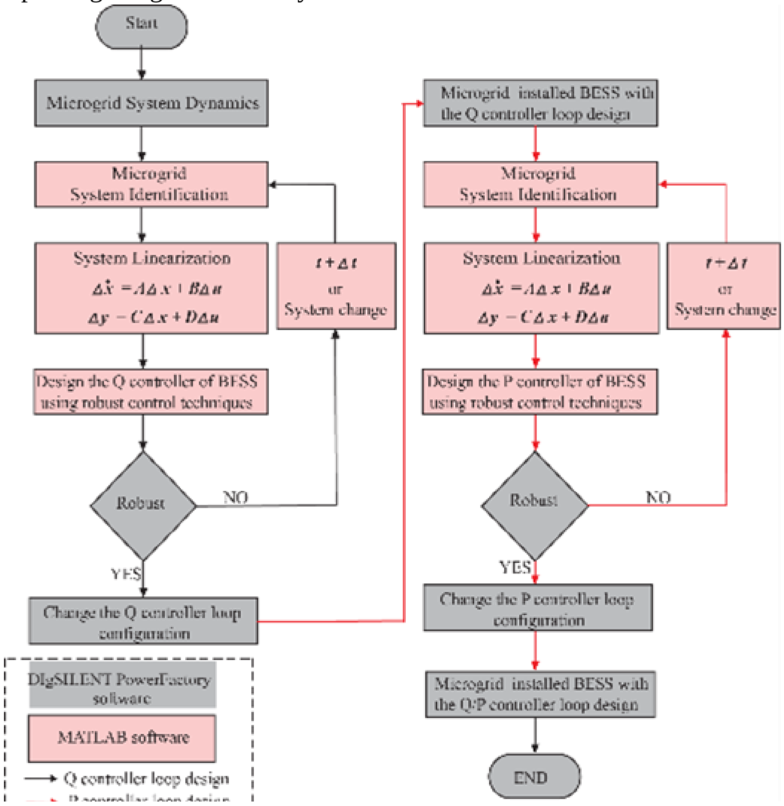

Fig. 11: Flow Diagram of Micro-grid

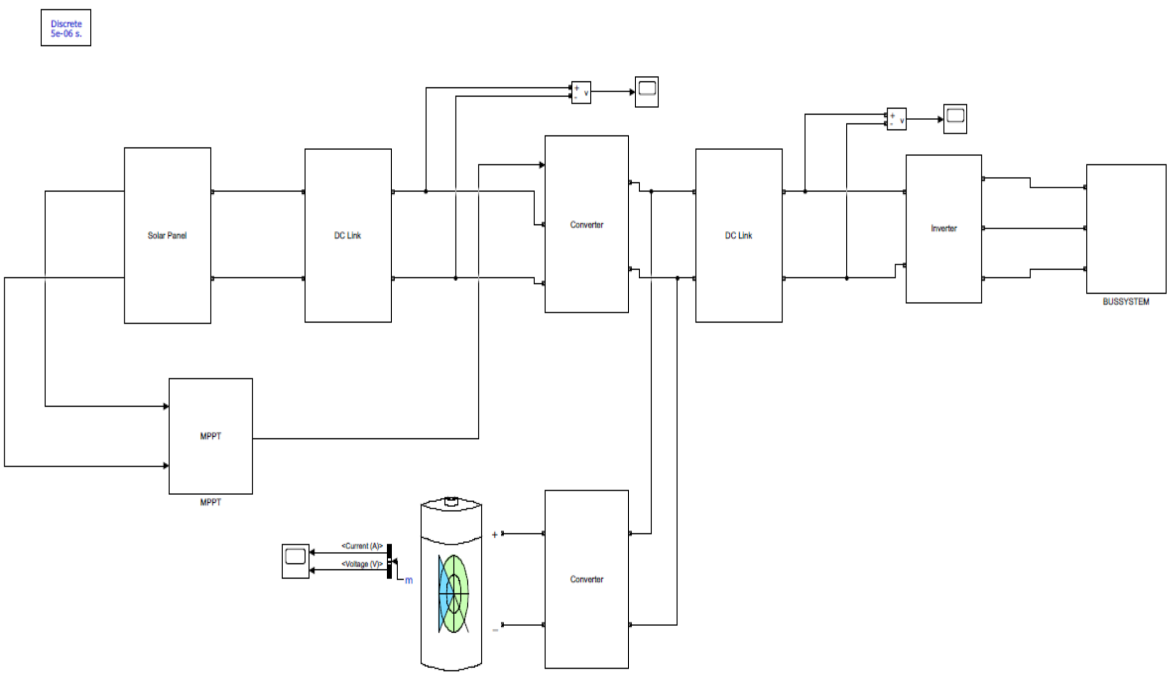

Fig. 12: BESS based Micro-grid

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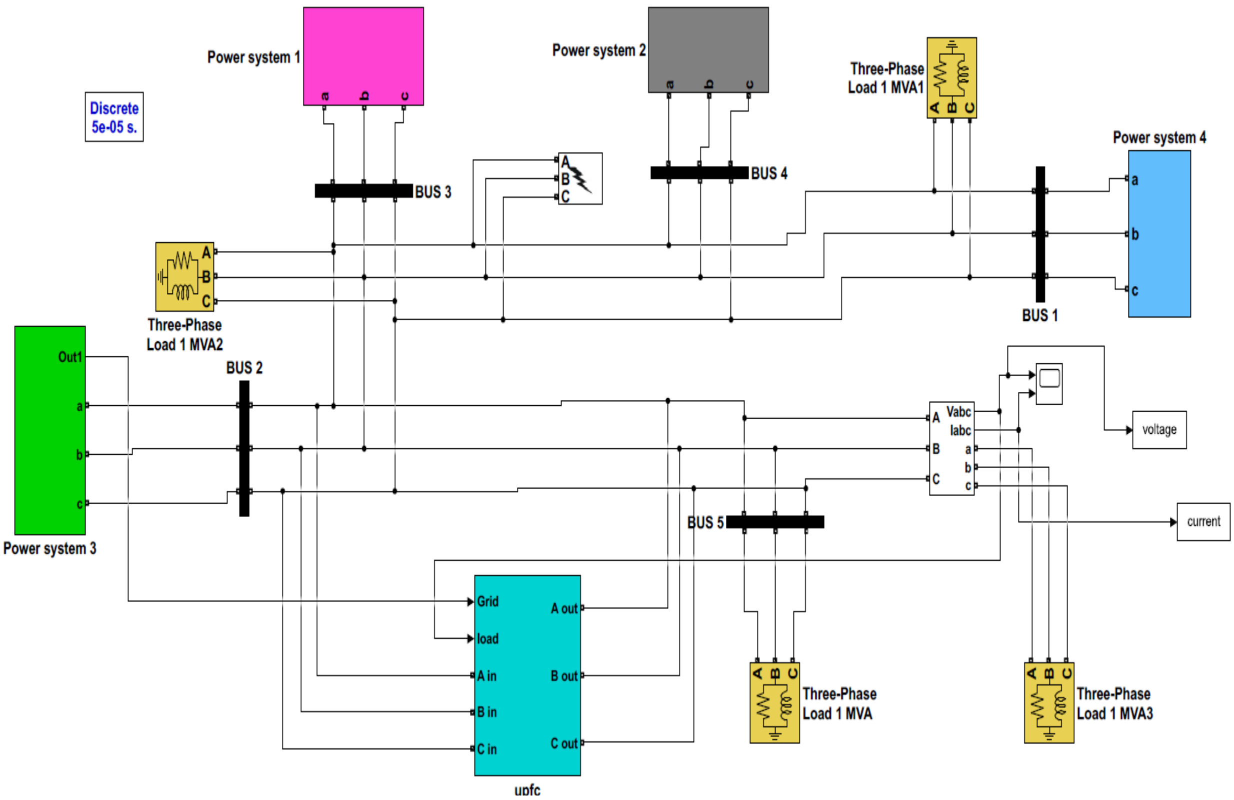

Fig. 13: FLC based Micro-grid

V. SIMULATION RESULT

The simulation of UPFC FLC has been executed.

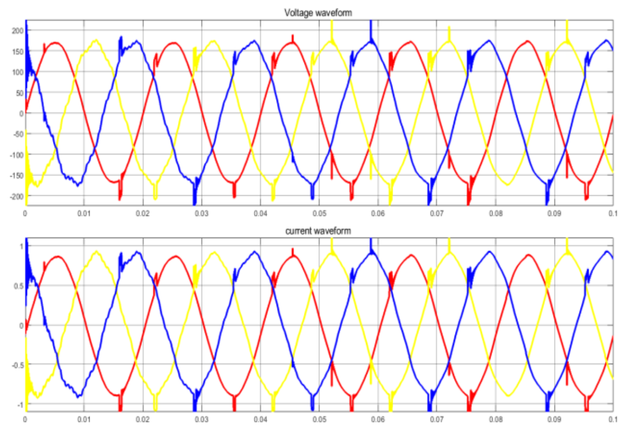

Fig. 14: Comparison of Current and voltage of FLC based Micro-grid

The above figure depict the comparison in between voltage and current of UPFC FLC.

The given figure is the simulation outcome of the measurement of o/p voltage of DC Link which is connected to the Battery energy storage system

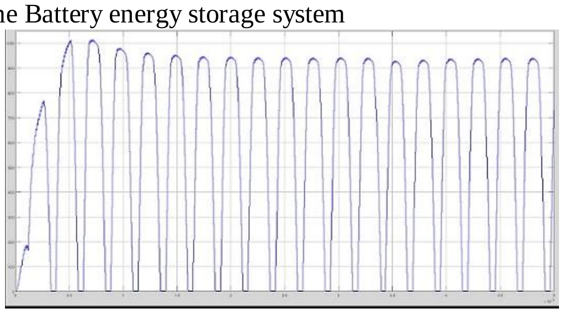

Fig. 15: Output Voltage of DC- Link

VI. CONCLUSION

This paper addresses the improved and productive execution of islanded micro-grid utilizing a battery energy storage system (BESS) with a fuzzy logic controller. To demonstrate the execution of the proposed strategy, the plan has been actualized on an islanded microgrid framework. The testing has been done using the software. The operation of the given fuzzy logic control is contrasted with robust control to demonstrate the predominance of the presented FLC. The simulation results exhibited that the presented BESS fuzzy logic and robust controllers have permitted that the BESS can control the dynamic and receptive power transfer in the micro-grid during any happenings, diminishing the recurrence/voltage fluctuation. Thus, the presented paper has been examined and satisfying results are obtained.

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