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A NEW SMART GRID DEVICE FOR EFFICIENT ACTIVE AND REACTIVE POWER CONTROL IN HYBRID POWER SYSTEM

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***Abstract*— The Micro grids consist of many parallel-connected distributed generation (DG) units with synchronized control strategies, which are able to work in both grid-connected and islanded modes. When the islanded micro grids are concerned, it is important to maintain system stability and achieve load power sharing among the multiple parallel-connected DG units. This project proposes an improved optimal sizing method for wind-solar-Fuel cell hybrid power system (WSF-HPS), considering the system working in stand-alone and grid-connected modes. This Method hybrid system which consists of a photovoltaic panel, wind turbine, Fuel cell, power convertor and a three-phase variation load. The load supplied is based on the photovoltaic panel and wind turbine, while the fuel cells are back-up for compensating possible power load shortage. The surplus of power produced will be Super Fuel cell system when the PV panel and wind turbine produce more power than required. Multi Converter (Fuzzy, Sepic) it used in parallel with other sources in Order to reduce DC bus variation. Matlab software is chosen for the hybrid system simulation.**

***Index Terms*— hybrid power system, Fuel cell, and Photovoltaic panel, maximum power point tracking (MPPT) Wind turbine, Active power sharing, hierarchical control, and droop control.**

I. Introduction

Renewable energy sources are known to support system hydrogen generation. Therefore, the newly developed idea is the ability to supply the load without any compensation by the wind turbine or PV panels solus in offing. Although photovoltaic panels are used as popular renewable energy sources, two major problems they encounter depending on power production are with solar irradiation and surplus energy storage. These problems can be solved by using other renewable energy sources and storage systems such as fuel cell and Supper battery. The PV systems and energy systems (ESs) are connected to the AC bus through the DC/DC/AC converters and wind turbines are tied to the AC bus through the AC/DC/AC converters. First, a unified detection method for circulating current and power-sharing deviation is described. Then, the improved control method for bidirectional converters in hybrid micro grid operated in island mode is presented to reduce circulating current and power sharing deviation, which includes the droop controller used to achieve automatic power sharing and the improved virtual impedance controller used to further reduce circulating current and power-sharing deviation[1]. In addition, the stability and dynamic response is usually degraded since the small-signal model of multiple converter system is usually changed significantly.

To cope with these two limitations, this study presents an improved droop control method with automatic master to correct the voltage regulation [2]. A load-sharing technique that will share harmonic currents among converters equipped with active compensation for harmonic distortion without mutual communication. In the following section, the fundamental theory of connecting ac power units in parallel will be described. The principle of sharing linear balanced load is adapted from the utility control theory. Applied on the fifth harmonic in two 90-kVA 400-Hz ground power units (GPUs) connected in parallel [3]. A droop control method based on the reactive volt-ampere consumption of harmonics of each interface converter is designed and implemented. The rectifier side regenerates the load power and executes the active power filter function to achieve unity power factor. Based on such high-performance VR(voltage regulation), a resistive droop method combined with the – droop and – shift scheme is then proposed to control the current sharing such that multiple VRs can be paralleled directly without any control interconnection[4],[5]. In the literature, there are many control schemes based on the droop method to share linear loads [6]. Nevertheless, nowadays the proliferation of nonlinear loads has become a problem,

Because the units must both share harmonic current and to balance active and reactive power [7]. In the grid-connected mode, the AC MG is connected to the upstream grid through a tie line at the point of common coupling (PCC) and there is power flow between MG system and the grid [8],[9]. To accomplish that goal, the proposed controller uses drop characteristics for active-power/frequency and reactive-power/voltage. Multilevel converters have received increased interest recently as a result of their ability to generate high quality output waveforms with a low switching frequency; the multilevel concept is used to decrease the harmonic distortion in the output waveform without decreasing the inverter power output [10].

II. POWER NETWORK IN ISLANDED MODE

The Fig.1 infers the arrangement of a basic micro grid. The system comprises of a collector bus, a converter, a bus capacitor C and a load. The load is denoted as a parallel combination of resistance R and inductance L and the load is presumed to be in an imbalanced condition. With all these assumptions, a fundamental frequency model of the converter is justified, where the converter is modeled as an average current source.

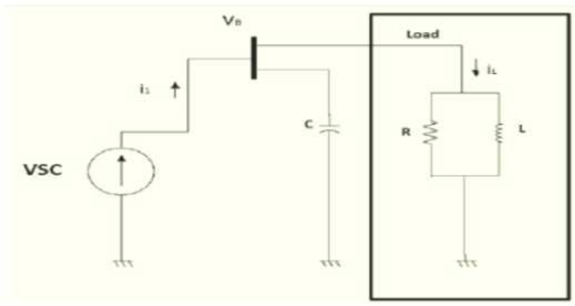

Fig.1. Converter based Power Network in islanded mode.

III. MGIN GRID CONNECTED MODE

There are various well established control method to control methods to control the inverters in a MG when it is operating in Grid connected mode. In most cases, either of constant current control or PQ control is used. These two methods are briefly explained below.

A. Constant Current Control

In this control method, inverters are forced to inject constant current output. The block diagram of this control shown in the fig.2.

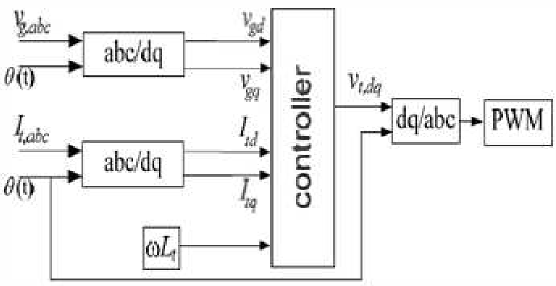

Fig.2 Block diagram of Constant Current Control.

The constant current control measures the load voltage Vgabc and the inverter current Igabc and transfers them to dq frame. The converter quantities Id and Iq are then compared with reference DC quantities Itd,ref(active power set point) and Itq,ref (reactive power set point) to obtain error signals. The error signals are then applied to proportional-Integral (PI) controllers to correct the errors and defined the reference voltage signals Vtd and Vtq.

These reference voltages are againe transformed to three phase quantities and are given to the pulse generator to generate pulses for the inverter. Overall, this process forces the inverter to inject the defined currents and at the same time it regulates the voltage at the connection point as measured from the grid side.

B. PQ Control Method

The block diagram of PQ control is shown in fig.3. The control structure of this type is quiet similar to the constant current control. The only difference between the two controls is the regulated parameters and they reach the same conclusion, which is output power control, in this control type, the regulated parameters are the active and reactive powers instead of the current.

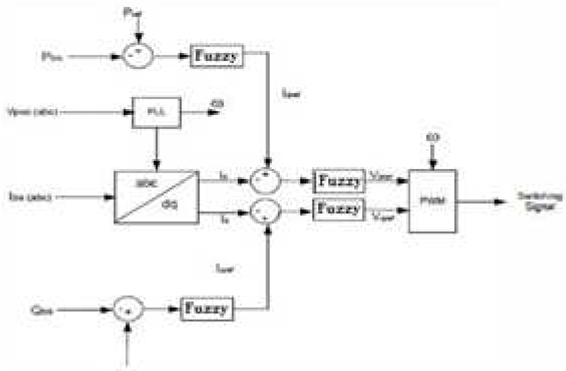

Fig.3 Block diagram of PQ Control.

Active and reactive powers are measured at the output terminal of the inverter and then compared with the reference values to obtaine the errors. These error signals are then applied to two PI controllers in order to obtaine Id,ref and Iq,ref. in fig.2

IV. SYSTEM MODEL

In this section we consider the existing system design and the proposed system.

A. EXISTING SYSTEM

The increased penetration of distributed generation (DG) units on the electrical grid systems, the renewable energy sources (RESs) including micro-turbines, photovoltaic (PV) systems and wind energy systems have been widely used in the distributed power systems in the past decades.

The DG units play an important role in reducing pollution, decreasing power transmission losses and improving local utilization of RESs, which becomes a strong support for the large-scale power grid.

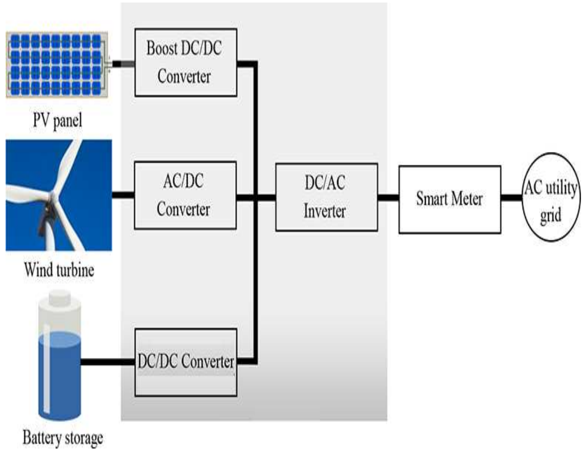

Fig: 4 Renewable Dc Source based DG units on the Micro grid System.

B. *Problem Identified:*

- DG units may also bring challenges to the distribution network such as inverse power flow, voltage deviations and voltage fluctuations are Very high.
- The Input Varies Distributed Generation using Supply Load Side Different Voltage generator Not Power factor Correction.
- High Harmonics Correction output using Micro grid Voltage.
- Ripple High this Load side using AC Voltage.
- The main drawbacks are that the initial installation cost is considerably high and the energy conversion efficiency is relatively low.
- This Total Problem Overcome The Proposed System.

V. PROPOSED SYSTEM

This project proposes an improved optimal sizing method for wind-solar-Fuel Cell hybrid power system (WSF-HPS), considering the system working in stand-alone and grid-connected modes. The proposed method is based on the following principles:

a) High power supply reliability,
b) Full utilization of the complementary characteristics of wind and solar,
c) Small fluctuation of power injected into the grid,
d) Minimization of the total cost of system.

The proposed method can achieve a higher power supply reliability while require less battery capacity in stand-alone mode. And in grid-connected mode, the optimization strategy based on energy filter is further utilized to achieve the optimal Super Capacitor. Thus, the proposed method can achieve a much smaller fluctuation of power injected into the grid.

In, Multi Converter (Fuzzy, Sepic) it used in parallel with other sources in Order to reduce DC bus variation.

In droop control method, the changes in load can be taken up by the DGs in a predetermined manner and the wireless control of parallel inverters is achieved with the utilization of system frequency as a communication link within a micro grid.

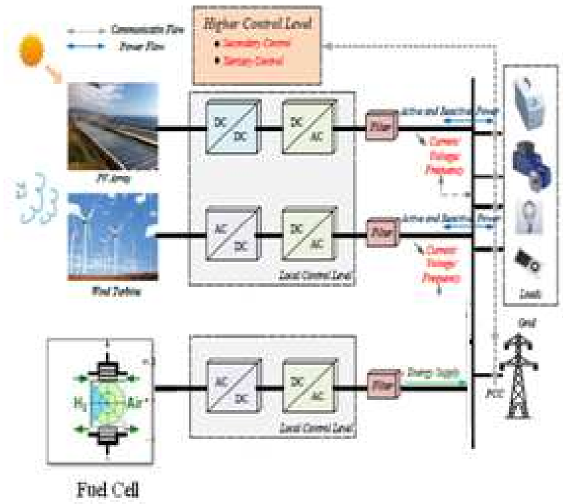

Fig: 5 Hybrid Model based source based DG units on the Micro grid System.

A. *Benefits:*

- Increase the efficiency of conversion using Maximize the output power.
- Multi Converter based Inject Current and Voltage reference based Control Result Output Best Load.
- Using Fuzzy Control for Mamdani Rule Better Output Of Ripple Reduction Load Circuit. The cost of the RES expected to decrease continuously in the future making them attractive for residential and industrial applications.

VI. DESIGN CONSTRUCTION

This Section consists of the following module design are to be explained in this section.

The basic architecture of an ACMG system, In PV systems and energy storage systems (ESSs) are connected to the AC bus through the DC/DC/AC converters, wind turbines are tied to the AC bus through the AC/DC/AC converters. In the case of islanding operation and Fuel Cell are connected to DC/AC Converters. RESs mainly provide AC power to the loads through the local control. In the grid-connected mode, the ACMG is connected to the upstream grid through a tie line at the point of common coupling (PCC) and there is power flow between MG system and the grid.

A. *Photovoltaic system modeling:*

The simplified equivalent circuit of a PV cell, called a four-parameter circuit, is shown in Fig.6, and it consists of light current (IL), series resistance (RS), saturation current (Io) and thermal voltage timing completion factor (α).

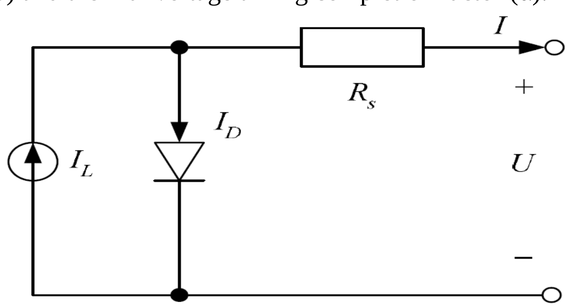

Fig.6: Equivalent circuit of a PV panel

The voltage-current and current-power characteristics have the important role of receiving maximum power in photovoltaic systems.

B. MPPT Technique

The typical P–V curve of a PV panel which can be used to design an asymmetrical FLC-based MPPT controller. With a fixed step size ΔVpv, the power variation ΔPpv is large at the right-hand side of the P–V curve, and is small at the left-hand size.

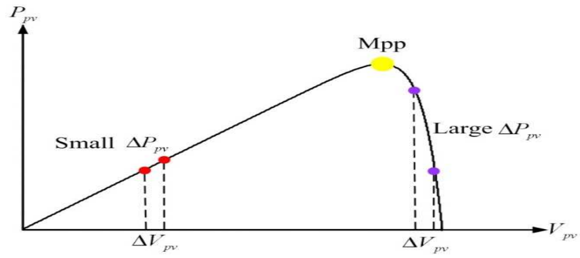

Fig 7. Concept for designing PV-MPPT

C. SEPIC Converter

Consider a SEPIC converter, if Vo, Io and Vin, Iin are output and input voltages and currents respectively and D isthe duty cycle, then Eqn. approximately holds (assuming ideal devices),

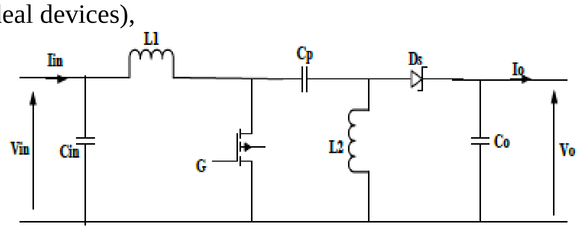

Fig. 8 SEPIC Converter Design

D. Fuel cell modeling:

In the fuel cell proposed, the changing conditions are pressure, temperature, fuel cell rate and air parameters.

The new values of open circuit voltage (EOC) and current (IO) can be calculated using Nerst voltage and the gas pressure values. ΔG,α and Kc parameters are also obtained based on the bipolar curve in the nominal rate with respect to the other parameters such as Low Heat Value (LHV), stack, fuel and air combination, pressure, and source temperature.

E. DC/DC Converter Controller

The unregulated output voltage of the FC is sustained to the dc/dc boost converter. Being unregulated it must be changed in accordance with a consistent normal worth (redulated dc voltage) by conforming the obligation proportion to the obliged quality. The voltage is supported relying on the obligation proportion. The obligation proportion of the support converter is balanced with the assistance of a Fuzzy Logic controller (FLC).

TABLE I: FUZZY RULE BASE FOR DUTY RATIO CONTROL OF DC/DC CONVERTER

Δd		e2						
		NB	NM	NS	Z	PS	PM	PB
e1	NB	NB	NB	NB	NB	NM	NS	Z
	NM	NB	NB	NB	NM	NS	Z	PS
	NS	NB	NM	NS	NS	Z	PS	PM
	Z	NB	NM	NS	Z	PS	PM	PB
	PS	NM	NS	Z	PS	PM	PM	PB
	PM	NS	Z	PS	PM	PB	PB	PB
	PB	Z	PS	PM	PB	PB	PB	PB

F. Wind Turbine Modeling:

The best wind turbine performance, wind speed limitation is a requirement AC/DC Converters based Grid Connect Maintain output Voltage.

G. Islanding

Islanding is a unique problem of the grid connected PV system. Islanding occurs on grid failure. Auto reclosure valve at the point of common coupling of the renewable generator to the grid is kept open offering the separation of the utility network with the grid. Else the voltage builds up on power generation without the energy absorption by the grid causing huge voltage unbalance resulting in system deterioration.

H. Grid Interconnection Standards

As the issues with the grid standards go on high, the design of the grid connected PV is subjected to follow grid standards which vary with the location of the grid over the globe.

Performance Parameters	Output
Power factor at 50% of rated power	0.90
Frequency range for normal operation	50±1HZ
Grid Voltage	600V
PV-Wind-Fuel Volt	210V-410-500
Grid Current Amps	3Amps

VII. SIMULATION RESULTS

The performance of the control strategy has been tested in simulation using Matlab/Simulink. A micro grid with a single DG unit, In this simulation, there is one local load connected to a DG unit and one common load connected to ac common bus, the microgrid is connected to utility through a static transfer switch (STS) disconnects the micro grid from the main grid, the total power demand of the load is supplied by the DGs..

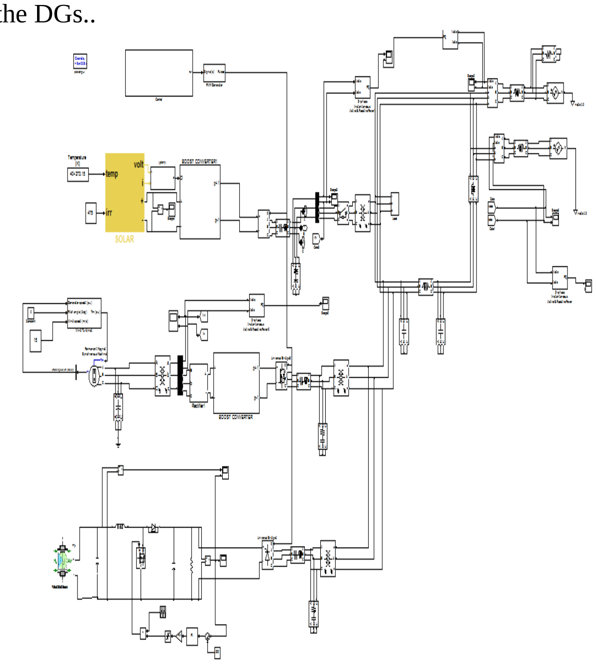

Fig. 9 Model of micro grid with a single DG

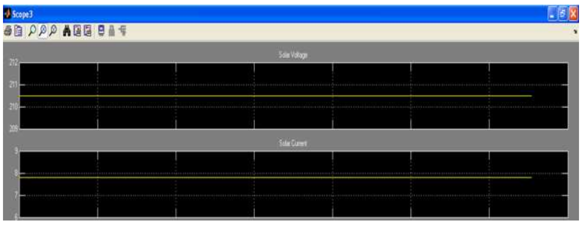

Fig. 10 Input solar panel Voltage and Current

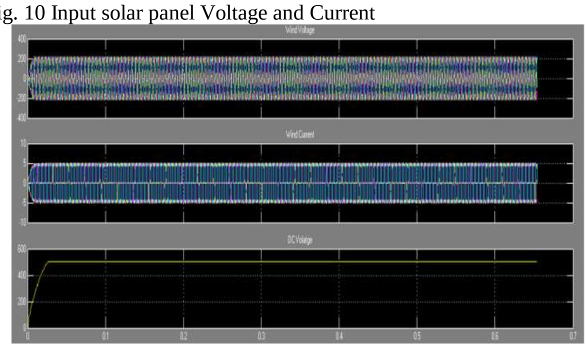

Fig. 11 Input Wind Mill Voltages, Current DC voltage

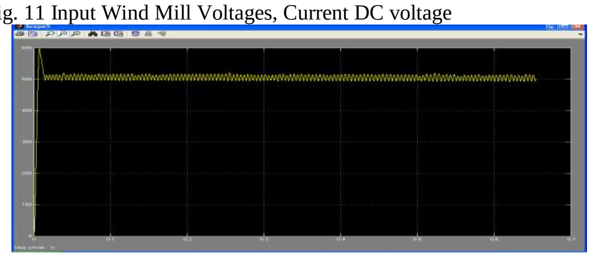

Fig. 12 Input Fuel Cell Voltages Output

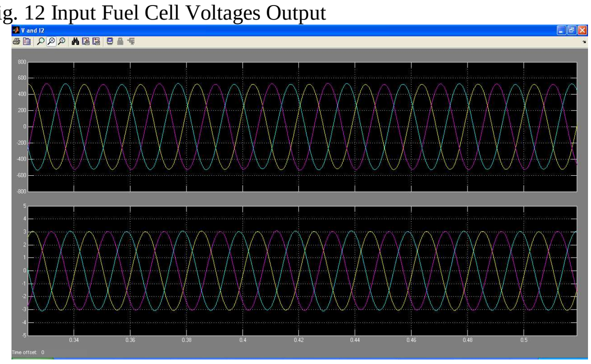

Fig. 13 Load voltage and load current in Grid connected operation of micro grid

VIII. CONCLUSION

Mini grids and hybrid systems have proven their efficiency in very different applications and with various renewable energy sources. In this paper, a control strategy for parallel connected DG System forming a micro grid was presented. This control strategy combines frequency and voltage droop method and inverter voltage regulation control scheme. Power produced will be Super Fuel cell system when the PV panel and wind turbine produce more power than required. Multi Converter (Fuzzy, Sepic) it used in parallel with other sources in Order to reduce DC bus variation. Matlab software is chosen for the hybrid system simulation Result of Best Power factor of 0.9Accuracy Using MG.

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