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Simulation of DC microgrid with distributed generation

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ABSTRACT -This paper represents a microgrid system implantation of Solar (PV)Energy storage device (Battery)and Supercapacitor (SC) and fuel cell to obtain isolated DC or AC load demand. The primary energy source is the solar (PV), where battery and Supercapacitor both are used for their discrete power density to supply transient and static load consecutively. Different different DC-DC converter connected with DC link bus which are joined with All sources vai control system. A control scheme modify their fluctuate DC voltage to bus voltage by means of these converters. In this work, SC is taken to work for a limited period where fluctuation in load demand. Battery and FC are used for energy storage purposes. Battery is to supply long term energy demand and Fuel cell used for backup source of energy which is used absence of solar energy and battery. Fuel cell charged the battery if it goes his minimum soc .SC is essential to meet temporary load demand. The flawless energy management concept with irregular load demand and solar radiation outline in MATLAB/SIMULINK.

Key Words:PV array, PI control stretagy,buck-boost converter, Super Capacitor, Nickel metal hydride Battery, Fuel cell.

1.INTRODUCTION

Recently, renewable energy sources are more popular for production of electricity and its increases day by day. Solar energy mostly used for the purposed of electricity generation. PV is the most useful renewable energy sources.

The hybrid system is shown in Figure:1 where solar power is most important power source of the whole system and (FC) is secondary power source. Here shown the hybrid Energy system. which has PV (solar energy)- Battery– SC (Super capacitor) FC (Fuel cell). This system is fill full DC load and AC load demand. Where battery and SC are used for energy storage purpose and feed power as requied as on time. the battery is main energy storing device .battery used at the system absence of PV power .Battery will supply long term energy sources which is charge by fuel cell. The battery has high energy density over super capacitor which is the main advantage of the system so battery used for long term energy demand.

SC are able to deliver hundred to thousand time more power than a similar sized battery. So the SC are used for transient load demand like sudden change in load demand and sudden change in solar irradiance. Here major challenges are to take continuous power to variation in load demand so many scientists and engineers to focus work of control of hybrid system. Here fuel cell used as secondary energy source which is used at absence of solar energy,battery and super capacitor.shown in figure all system connected by DC-DC bidirectional controller.which make system compact and simple.

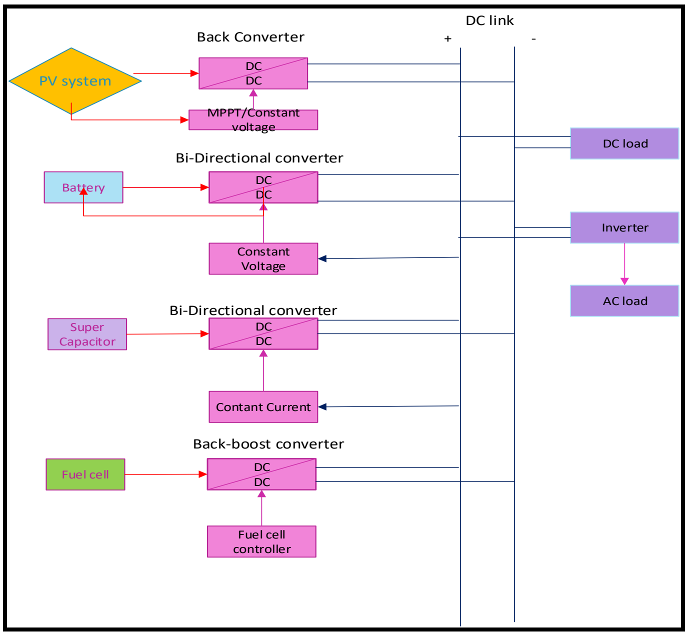


Fig.1 Energy managment

In this paper hybrid system PV-Battery-SC-FC system has been used for the application of separate DC load isolated from the dc microgrid with distributed generation. this system used for small company, commercial field, industrial facilities, hospital and military camp etc. here the Battery and SC both are used for energy storage purposed .battary used in the system capable to supply continuous power in variation in load demand. PV the main source of energy which are connected to battery and SC. Solar energy charge the battery and supercapacitor to its maximum soc level.

In this paper, control scheme has been proposed for PV system. PV is main energy sources which are used for DC load demand and also charged battery and super capacitor when load demand less than generated power. Battery controller charged battery at its maximum SOC and also discharged min soc level which are link together to PV and SC controller and FC controller.

Section II solar system molleling followed by control purposes of system in section III and section IV the energy management control scheme has been described with individual controller model. In section V system explanation is available with comparison of objectives and with its result followed by analysis which is conclude in section VI.

II. SOLAR SYSTEM CONTROLLER

In this paper are used at primary sources. the buck converter connecting with maximum power point tracking to always given to extreme available solar power .Solar array are connected with DC load. Its production varies with fluctuating irradiance and temperature. Fig 3 description about control scheme of solar system.it has two operative modes; maximum power point tracking and content DC link bus voltage controller. The solar controller always works in MPPT mode which is show in fig 2.

In this paper,solar array power applied incremental conduction method used for extreme power .which detecting to its voltage (Vpv) and current (Ipv) by solar array. Solar power to its maximum power always regulates by MPPT. Pv power sources given to load demand and extra power charged battery and super capacitor at maximum limit . PV panel is connected in series DC/DC buck converter is used to control pv current.in this control scheme DC bus are connected to 10 modules in 2 strings (each string with 5 modules in series)

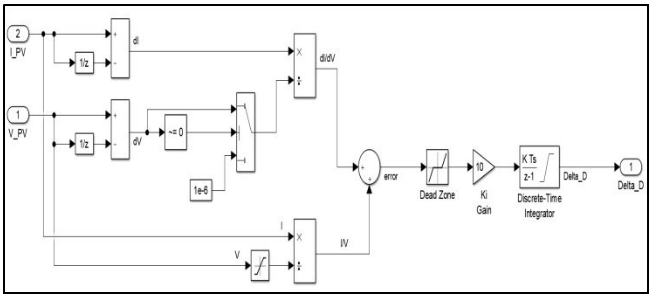


Fig.2 Control strategy of MPPT

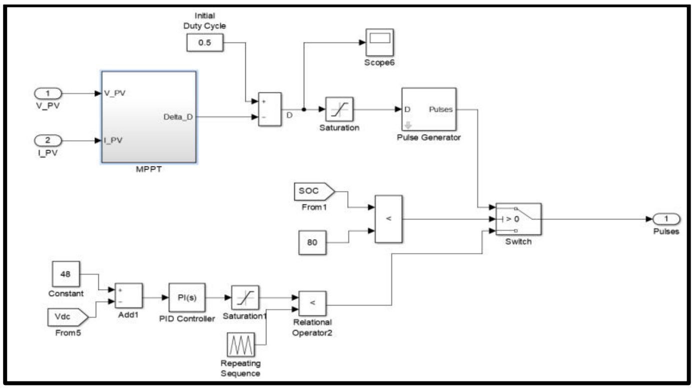


Fig.3 control strategy of solar system

III.CONTROLLER OF BATTERY: -

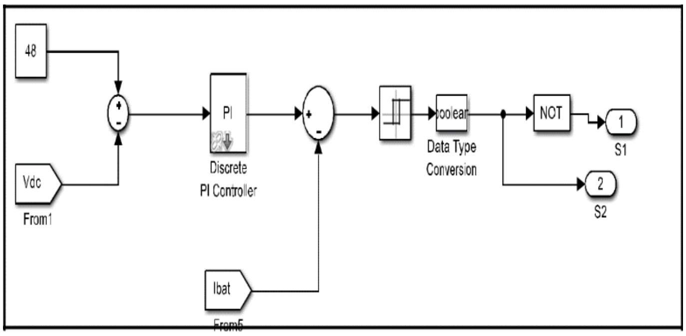


Fig.4 controller of Battery

Show in figure 4 where Battery connected with buck-boost converter through dc link. Here we used hysteresis current control technique for battery control. In this procedure calculated DC link voltage is compared with Reference voltage. Using PI controller used to decrease error and generated reference current for battery. It contains positive or negative gain may depending on charging and discharging of SC. Battery currents are limited by Battery controller for regulation purpose and safety purpose. Battery current follows the reference current and produced pulses S1 and S2 to controller of Battery.

- battery used the system more secured at different different load condition. The energy exchange between DC bus and all source can be recognized by in view of following control specifications.

- Primary control parameter obtained by the incremental conduction method of mppt which is given Maximum power which is depend on PV power of solar irradiance and temperature
- All energy source in energy management strategy connected with load input
- Battery charging-discharging cycle describe here.Battery get charged by PV power and if in any case Power source not allowable these time fuel cell get charge the battery his maximum soc and Battery is allowed to discharge up to minimum limit.
- Operation of SC near to its fully charged voltage being fast response axillary source.
  - Battery controller used to battery charged and discharged by buck-boost converter which is charged by pv power and discharged by dc load demand.
  - safe operation of SC with DC link voltage equilibrium by preventive its current discharging and charging limit.

the above objectives applied here, pv power connected to hybrid control strategy by which are fill full DC load demand . And also charged battery and supercapacitor. This system has been designed in MATLAB SIMULINK with system dependability with charging load condition.

IV.CONTROLLER OF SC: -

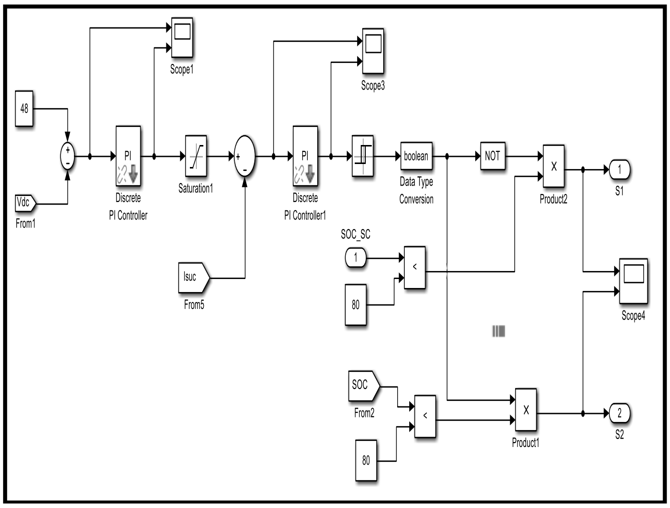


Fig 5 Controller of Super capacitor

The Supercapacitor's are connected to DC link by a two quadrant DC-DC buck-boost Converter. This converter is directed by the complementary pulses put in to two switches S1 and S2. This converter is operating in three manner: off mode, charging mode and discharging mode. The SC current can be positive or negative depending on its charging or discharging state. At the time of discharging, SC current is considered to be positive and at the time of charging, it is negative.

Figure.5 shows the control strategy model of the SC converter. Here, SC converter is controlled by two cascaded PI controller consists of external voltage by means of inner current control. DC link voltage (Vdc) is observed and compared with the DC link voltage reference (Vref) to produce the error value. This error is minimized by the PI controller and SC current reference (Isuc) is produced. This Isuc must be limited to maximum acceptable charging discharging currents by means of SC current balancing function.

V. CONTROLLER OF FUEL CELL

The Fuel cell is used to supply temporary energy to hybrid system. when battery output power becomes less than load demand the excessive power of Fuel cell used to charge battery and output variations get reduced. The Fuel cell are able to deliver power toBattery for load demand. Fuel cell gives direct current at low voltage. Therefore DC/DC boost converter is connected to Fuel cell. Due to higher running cost of Fuel cell, a new control strategy has been proposed with FC to save fuel.

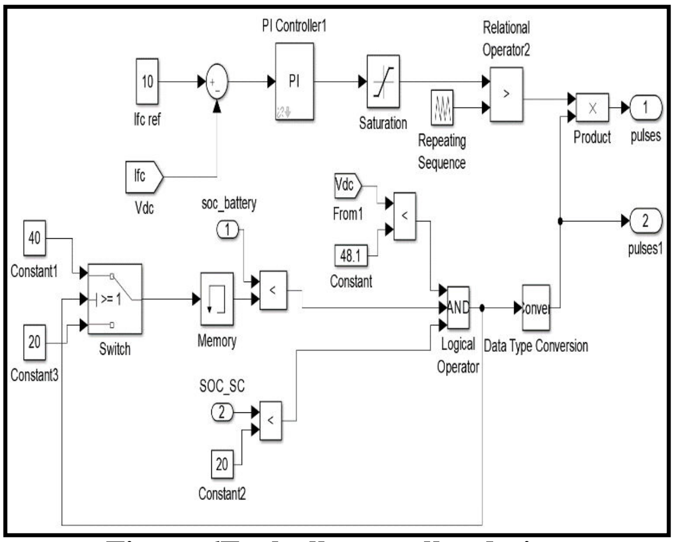


Figure 6Fuelcell controller design

Figure.6 shows that a relay decides the ON and OFF state of FC and if Battery SoC (BatSoC) is lower than minimum allowable SoC limit of Battery (BatSoCmin), FC current (Ifc) will be regulated to its reference value (Ifcref) and if it is more than maximum SoC limit of Battery (BatSoCmax), FC current will be zero. These control parameters can be chosen depending on system requirement and load demand. A current based MPPT technique is simulated here to maintain the FC current to its maximum value.

System component	Ratings
PV module	Voltage at MPP=30.7V, Current at MPP=8.15A, Power at MPP=250.205Wp ,at STC
PV Array	Power at MPP=5 KW , at STC
Battery	Nickel metal hydride 24V, 400Ah, Bat SOC min=20%, Bat SOC max=80%
Super Capacitor	Csc=300F,ESR=0.00004Ahm ,Rated Voltage=30v, ,Iscmax=50,Iscmin=0,
Fuel cell	PEMFC-6KW-45Vdc
Dc-Dc converter	L1= 0.0477mH
Bidirectional converter1	L2= 2.7429 e-5 H
irectional converter 2	L3= 1.7429e-5 H
Dc link voltage	48V
Load	1500 w (average load)

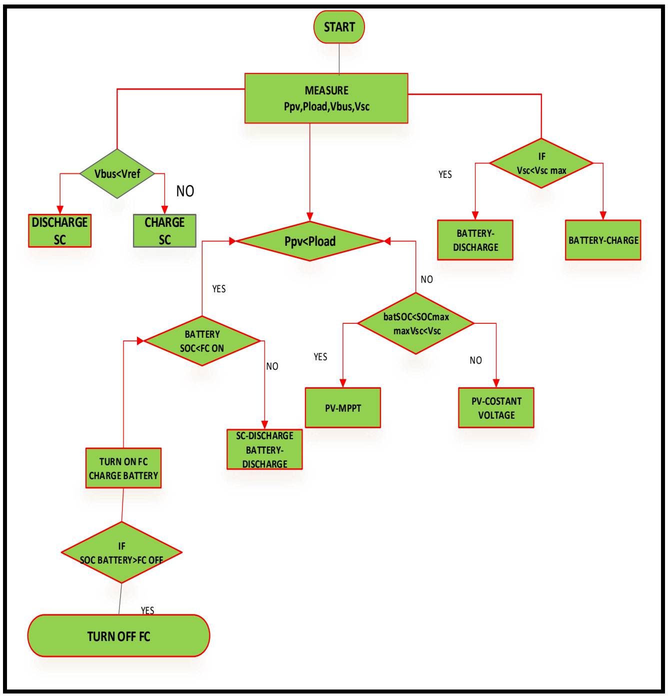
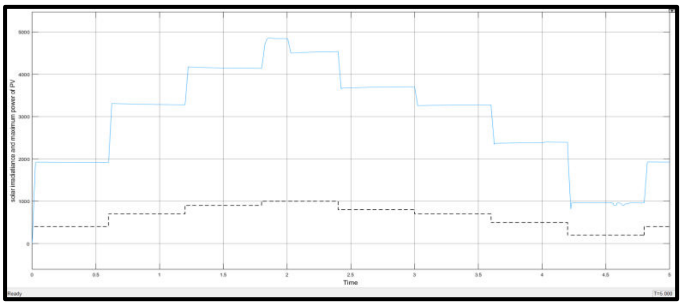


Fig 6 Energy management system

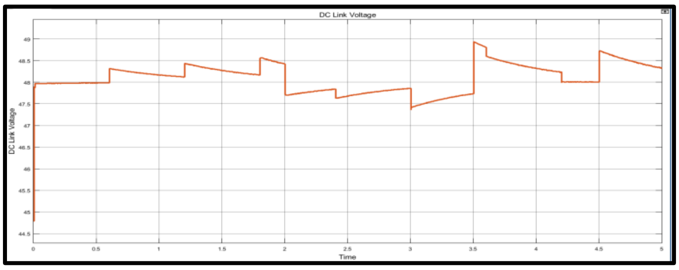
TABLE.1 SPECIFICATION OF HYBRID SYSTEM COMPONENTS

VI. SYSTEM DESCRIPTION

A microgrid system control plan show in figure.6 with adjustable load demand and variable solar irradiance with constant tempruture .the desired load demands The system should always be able to satisfy. In table 1, the rating converter specifications with the system components are listed. three different DC-DC converters is the major source by mean of Three sources are port with standalone DC load. have been taken consequently their size, so that this can be supply the load, and also charged the storage devices at its maximum state of charge, when pv is unobtainable they can take the load demand by such that size of battery and SC.

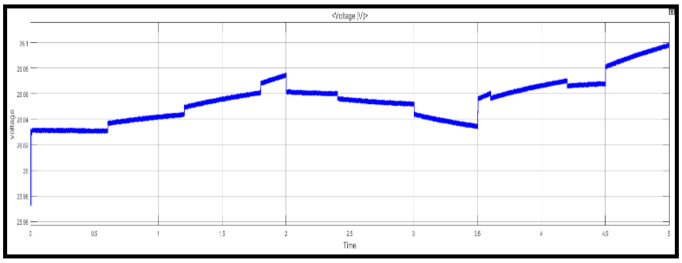


MAXIMUM POWER OUTPUT OF PV AT VARIABLE IRRADIANC

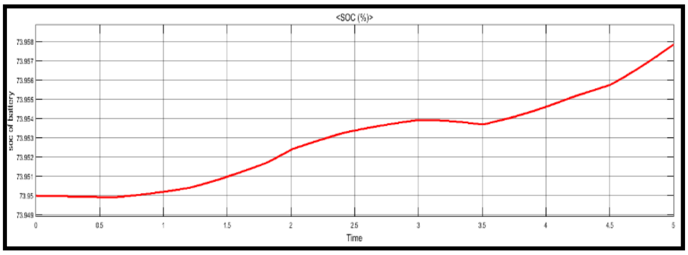


DC LINK VOLTAGE OF PV SYSTEM

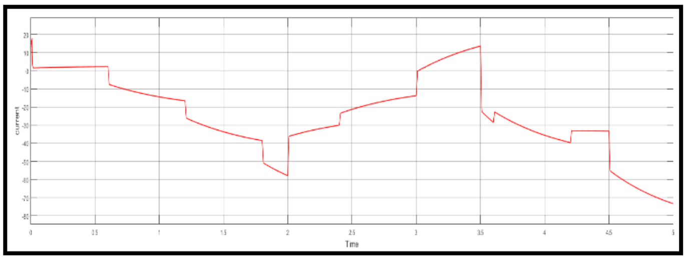
RESULT& DISCUSSION



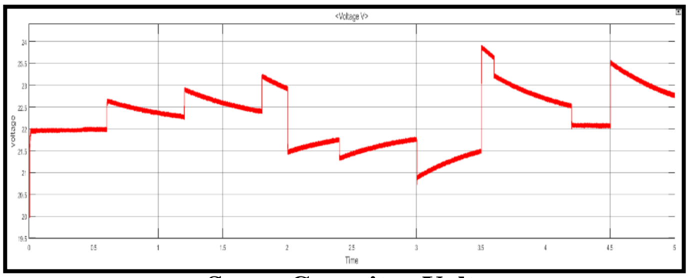
Battery Voltage



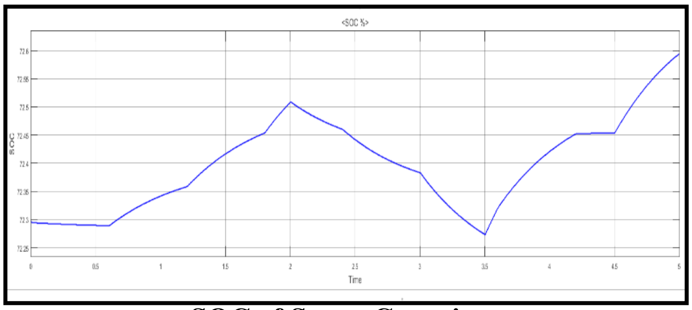
SOC of Battery



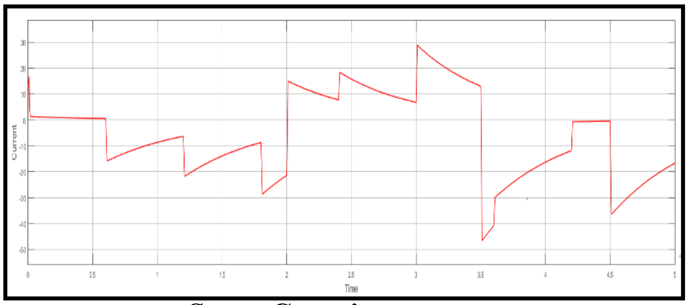
Battery current



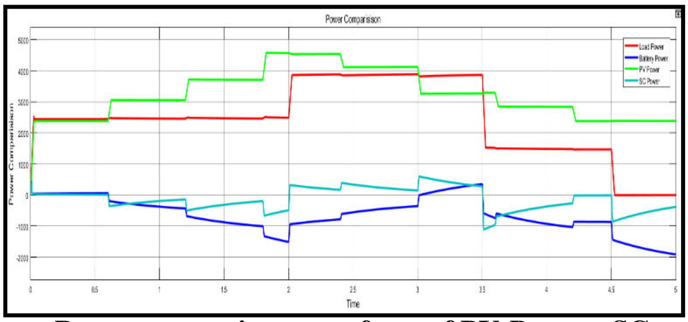
Super Capacitor Voltage



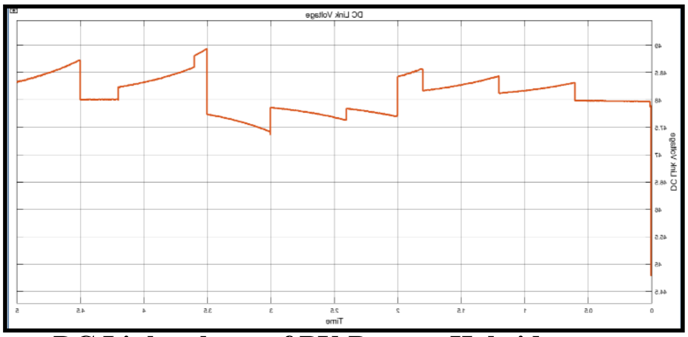
SOC of Super Capacitor



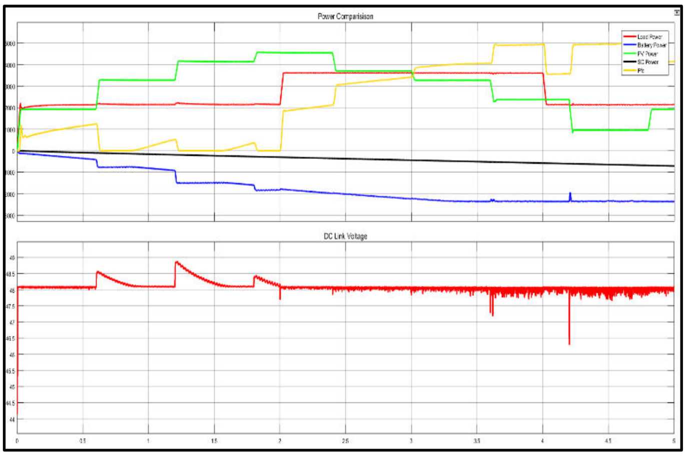
Super Capacitor current



Power comparison waveform of PV-Battery SC Hybrid system



DC Link voltage of PV-Battery Hybrid system



SIMULATION RESULTS OF PV-BATTERY WITH SC-FC HYBRID SYSTEM

VI. CONCLUSION:

.we studied a most appropriate energy management control scheme of PV-Battery-SC-FC hybrid system. Our analysis here for continuous load condition here PV and fuel cell used as source energy and SC used for transient load condition because SC given fast response then battery. And battery used for back up source for fluctuation in load demand. Battery charge by fuel cell so this system given continues power given to various load condition. The simulation shows that classical PI controller-based control system for microgrid system which supplies the DC load, also keep battery and SC virtually fully charged and decreases FC usage by minimize FC running period. The simulation outcome shows the dependability of power supply and decreased fuel usage.

FUTURE SCOPE

our new innovation in this simulation are axillary system source side like fuel cell and battery are backup sources which are used as axillary system which operated automatically only for small period on poor power quality time and when variation in load demand. fuel cost of fuel cell is much higher than other sources running cost, it provides a large amount in system cost value so it only by minimize the use , the size and the annualized cost of FC system can be decreased. This criterion has been considered in the proposed energy management. The simulation results show the dependability of power supply and reduced fuel usage.

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