



# Design of standalone hybrid system for mitigation of energy storage problem in frequent load shedding regions

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Abstract- Necessity of electricity access in remote area is the main reason for expanding decentralized energy system such as stand-alone power system .The paper presents an attempt to mitigate the energy storage and reactive compensation problem due to frequent load shedding in standalone hybrid (pv-wind) hybrid system used for rural applications. The proposed hybrid renewable energy system is equipped with shorted stator induction generator (SSIG) to ensure charging of batteries during no load condition especially at frequent load shedding asynchronous (AC-DC-AC) link to reduce the DC ripples and AC harmonics, SPWM or SVPWM inverter battery system so as to achieve constant output and fixed frequency at the output of wind turbine generator, so as to provide a stiff voltage source. This paper presents a scheme to reduce the total I<sup>2</sup>R losses at the output of the DFIG or SSIG used in wind turbine generator. The proposed system is intended to be applied in rural plants as a low-cost source of high quality AC sinusoidal regulated voltage with constant frequency.

Keywords—SSIG,load shedding,asynchronous link,ZSI (key words)

#### I. INTRODUCTION

Electrical energy it vital in every aspect of our day to day life. A fundamental need in the developing countries is the electrification of rural areas and remote villages.But in today's scenario there are lots of problems faced due to frequent load shedding. The electricity providing utilities are managing to provide the electricity to the increasing population by adopting various methods. But where their attempts fail, they pot to give the service to everyone by load shedding of the zone wise. Here is the point where there lies the problem for standalone hybrid battery storage systems. The paper focuses on this issue which can occur during frequent load shedding, if it persists for a longer period then the aim of UPS is not met .The standalone energy conversion systems have the inherent problem of fluctuations in the magnitude and frequency of its terminal voltage with changes in wind flections and load which can be overcome by using AC-DC-AC link. According to the literature survey the dynamic

response/dynamic reactive power compensation can be achieved to some extent by using DC link Impedance source (ZSI) hybrid active filters. But it should be noted that filters do not block harmonics they generate harmonics.

Solar photovoltaic (PV) energy is the dominant one among these renewable energy sources due to its ready availability, cost-effectiveness and reliability. As a result, the presence of PVs in the electrical power system are increasing, especially for single phase low power ( $\leq 5$  kW) utility grids, but PV sources are capable of generating DC voltage at the output while AC voltage is required to connect these sources with grid. On the other hand, PV sources have the maximum commercial conversion efficiencies of 16%-20%. In addition, the PV characteristics depend on the environmental conditions like irradiance intensity and temperature. It is possible to get only one maximum power point (MPP) on the characteristic P-V for a specific set of operating conditions [1,2], so inverters with maximum power point tracking (MPPT) capability are required in between the PV source and the grid for reducing the cost of energy and utilize the maximum amount of available power from the PV as well as enhance the energy transfer efficiency from the PV sources to the utility grid. The MPPT-based PV inverters can be either single stage or two stage, but the typical PV inverters are based on two stage setups [3-5]. The two stage configuration has the advantages of easy control of MPPT and freedom to use the higher switching frequency of the DC-DC converter than the inverter, which in turns minimize the size and cost of the converter [6].

## II. BATTERY STORAGE AND POWER ELECTRONICS

Standalone wind-PV hybrid system are good solution to electrify isolated locations ,which are far from electrical distribution network. This hybrid system with the battery storage is a perfect scheme to provide uninterrupted supply to the remote areas only under the proper management of power under no load and on load conditions [4].There is sufficient literature available regarding the design and modeling of standalone hybrid system (PV,wind,diesel,tidal,etc) . Majority of the survey describe about the problems regarding the inverter design for mitigation of AC harmonics in offgrid or mini grid systems and design of controller and converter in the grid connected system. Charge controller in off grid is needed to protect the battery from overcharging .Battery needed to provide power when required. The paper aims at using ZSI for the solar sell and AC-DC-AC link for the wind turbine.

## III. PROPOSED SCHEME OF HYBRID OFF GRID SYSTEM



Fig.1 Structure of the proposed scheme for the off grid system.



Fig.2 Impedance source circuit

In the proposed system the output of the Induction generator is fed to the load via AC-DC-AC link. This asynchronous link consists of phase controlled rectifier and a line commutated inverter .A DC link converter (rectifier & inverter) used to maintain the variable output voltage and frequency of the standalone WTG to fixed voltage and frequent [1]-[6]. The DC link inductor filter reduces the DC ripples providing a stiff voltage source for the inverter. With this arrangement as the power factor is 1 this link can be used to connect to the resistive loads. The output from the link is allowed to pass through a rectifier which gives a DC output that can be connected to DC loads as well as the battery through charge controller. The PV cell gives the DC which passes through DC-DC converter whose output is given to ZSI (AC loads), DC loads and charge controller to connect to the battery[7]. In this manner the proposed scheme is an attempt to provide the energy from the hybrid system to the AC load and DC loads, also store the excess energy in the battery. Here there are two cases to consider,

## Case 1: When DFIG is used for wind turbines

All the electromagnetic machines require torque current  $I_T$  & magnetizing current  $I_M$  to produce the magnetic flux ,because there are no permanent magnets in DFIG or DFIM. These two currents are orthogonal vectors and so cannot added directly.  $I_M < I_T$ , so it can be shared between the stator and rotor windings, so if all the  $I_M$  is supplied to rotor winding, the stator will have small torque current with unity power factor. This strategy is based on direct control of stator active and stator reactive power by selecting appropriate voltage vectors on the rotor side.

## Case 2: When SSIG is used for wind turbine.

The major standalone hybrid systems in the developing countries use DFIG for the wind turbine ,but in a single inverter battery based DFIG, it should be noted that if AC load at the stator terminals is not present(i.e. open circuit at stator terminals), the system fails to charge the batteries with the available wind and solar energy. It is therefore proposed to charge the batteries through rotor side inverter by short circuiting the stator terminals when the AC load is not present.

TABLE I. - TECHNICAL PROPERTIES OF UNITS IN THE HYBRID SYSTEM

Wind Turbine	Output Voltage : 12/24V Power:
	600W Max Power : 750W
PV Panel	Power: 190WType: Mono
	crystalline
	Efficiency: %17.75Max. Power
	Voltage : 37,08V
	Max. Power Current :
	5.12AOpen Circuit Voltage :
	44.48V
	Short Circuit Current : 5.54A
	Operating Temperature Range:
	40°C / +85°C
Charge	600W WT/600W PV 24V
Controller	charging control unit WT and
	PV voltage read
	LCD display WT and PV
	current read

	Immediate data transfer and record feature Battery power read Connect / disconnect wind
	turbine to circuit short circuit
	protection
	protection
Battery Group	Battery Voltage : 12V Type:
	Gel-type sealed battery
	Battery Capacity: 100Ah
Inverter	Power : 3kW Immediate Power
	: 6kW
	Efficient >85% Type: Exactly
	Sinus
Pole	Height: 12 m Octagon chronicle
	pole
	Hot dipping galvanization
	covered
Street Lighting	Power : 40W Lumen: 3000LM
(LED)	Input Voltage: 12 V Operating
	Frequency : 47-63HZ
	Operating Temperature: -30 /
	40°C Operating Efficient >90%

## IV. POWER ANALYSIS

From the literature survey, it states that in the absence of stable or constant power the loads may malfunction, fail prematurely or not operate all. According to [1] a transformer is used after the inverter which gave the THD values well above IEEE standard limit of 5% .The harmonic current is a cause for equipment failure, a serious issue for off grid systems. Therefore in the proposed scheme instead a AC-DC-AC link is used which works as both booster and maintaining the constant voltage and frequency .So as to reduce the DC ripples and AC harmonics. The survey [3] using pure sine wave inverter have showed that at no loads there are only voltage transients for resistive load at THD of 7.45% (less than 5%). However as the resistive load is increased the voltage transients and current transients both have increased the value of THD upto 8.56 % [3] -[2].Whereas for inductive load ,total demand distortion is in the acceptable limit (less than 5%), but for voltage is still more than IEEE standard limitation.

The proposed aims to give the following outcomes for a single phase off-grid hybrid system.

I. According to the survey using ZSI for PV and wind the following table gives the output power of the individual renewable systems and then the hybrid systems

TABLE II- CONVENTIONAL SYSTEM

System	Power output (W)
PV + ZSI	$\approx 10$
WIND +ZSI	$\approx 10.5$

HYBRID + ZSI	≈ 13.5

From the above table it is expected to achieve maximum power using hybrid power system.

II. Output of proposed system.

TABLE III- PROPOSED SYSTEM

System	Power output (W)
PV + ZSI	$\approx 10$
WIND+AC-DC-AC	≈ 11.5
HYBRID+ZSI+ac-	≈ 14.5
dc-ac	

## V. CONCLUSION

From the analysis it is expected to have a maximum power from the proposed hybrid system, satisfying AC loads, DC loads and battery charging at no loads. The simulation of the proposed hybrid system can give an agreement between schematic and mathematical modeling. The paper is intended to attain an adequate switching optimization, excellent dynamic responses and high accuracy in steady state operation. After the simulation results and FFT analysis, it is proposed to use a MOB DC-DC converter instead a conventional converter, which may still give more power output with reduced THD between 4 to 4.5 %.

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