

Power Quality Issues in Grid Integrated Solar and Wind Hybrid System: A Review

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Abstract - Nowadays, the call for energy has substantially extended due to which fossil fuels are consumed at an excessive charge. If the existing situation continues, younger generation is probably disadvantaged of their use of energy. To prevent customers from lagging of energy and to meet their needs, hybrid system is a precise solution. Solar and wind energy are to be had abundantly in huge quantity and can be considered as reliable source of energy generation. Wind/solar hybrid RES is integrated to grid using grid interface inverter which incorporates power electronic switches which induce harmonics in the grid thus reducing the quality of power in the load side.

IndexTerms - Doubly Fed Induction Generator, FACTS Devices, Power Quality, Renewable Energy system

I. INTRODUCTION

Renewable energy systems are proving to be promising and environment friendly resources of energy era, especially, in countries with insufficient fossil fuel assets. In current years, solar and wind energy based systems were drawing extra interest to offer power to remotes or electricity deficient regions.

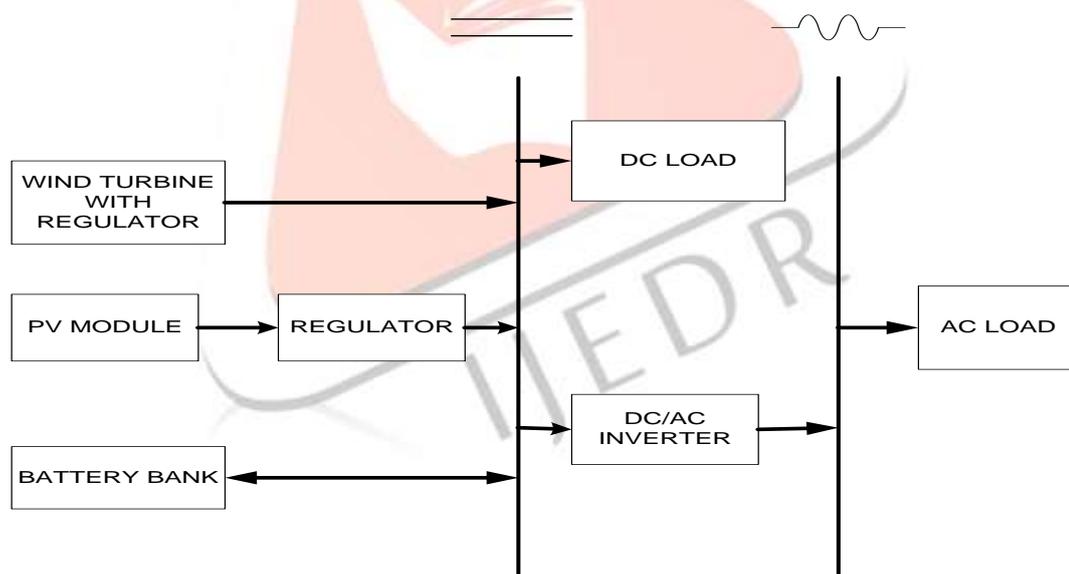


Fig1: Wind & Solar Hybrid Energy System [13]

These resources are going to connect in to National grid or Utility grid. It operates in two modes. They're Island mode and Grid connected mode. March 31, 2012 the grid interactive power generation from RES is 24914 MW i.e. around 12.1% of the total installed energy capacity. Further Ministry of New and Renewable Energy (MNRE), government of India is targeting to achieve 20000MW grid interactive powers through solar and 38500MW from Wind by 2022. At some point of combination or grid integration there are numerous problems growing like Synchronization, Power Quality and Protection, load sharing and so forth.

II. LITERATURE SURVEY

Some of papers published in IEEE journals and conferences have been reviewed; literature discussed about power quality and reliability in renewable energy generation, various forecasting elements concerning harmonics reduction have been highlighted.

It mainly centered on diverse methods of power quality improvement strategies in hybrid power systems. SVC controller is used to mismatch of supply and call for of reactive energy in wind diesel hybrid system under varying situations of load and the input of wind energy. Ann models were evolved for variable slip/speed wind-diesel autonomous hybrid system. About 70% to 80% of power quality related issues can be attributed to defective connection and wiring [1]. A overview on grid integration and power quality problems related to the combination of renewable energy systems in to and functions of power electronics devices and flexible AC transmission system relate to these troubles. Latest developments in power electronics for the integration of wind and photovoltaic (PV) energy generators are presented. Discussion approximately common and future tendencies in renewable energy systems based on totally on reliability and maturity of every era are offered. Type of numerous power quality problems utilized by specific researchers has been executed. Applications of various techniques as carried out to mitigate the distinctive power quality troubles is likewise offered for consideration in [2]. Simulation and hardware model of hybrid solar and wind energy system linked to grid is carried out. For this, evaluation is performed on simulated version to determine sag, swell, source voltage, supply current, percentage of THD. The prototype hardware version of single phase version is also evolved. Seven level inverter is used to enhance the overall power quality of the system. The model is simulated through math's laboratory simulation package deal and also layout of seven level inverter studied. The non-sinusoidal supply voltage , supply current and load voltage have become sinusoidal with using controller. The controller reduces the reactive power introduced by PV source thus improving THD to approximately 3% of the system. The voltage at the point of common coupling will increase 29.11% with the usage of controller in [3]. Paper offers with modeling work and simulation of wind-solar hybrid RES and interfacing it to the grid with a power quality improvement characteristics. The grid interface inverter additionally acts as hybrid series active filter (HSAF) with Synchronous reference frame (SRF) method using Self Tuning filter (STF) to mitigate troubles associated with voltage unbalance and voltage harmonics inside the grid side. It additionally makes a contrast among the traditional low pass filter and self-tuning filter. A reduction in overall Harmonic Distortion (THD) will be discovered with Self Tuning filter. The THD that is anticipated to move below 5% here, the same invert4er served functions- one as a grid interfacing inverter converting DC to AC and second one as a Voltage source inverter of series active filter [4]. Fundamental power quality problems as Voltage distortion, Harmonics and voltage sag in a wind and solar based hybrid power system were represented. Because of power quality troubles are anywhere, it should be mitigate for better power quality. Voltage sag is the most common power quality trouble in energy system. If we take into account a hybrid power system power quality problems is continually there. Power quality troubles can be mitigated by the use of static synchronous generator and active filter. This will help to attach greater numbers and extraordinary kinds of power devices related to grid with higher power quality. Some other PV devices is used as source of STATCOM for higher usage of non-conventional useful resource [5]. THD contrast of 5 level and 7 level inverter were carried out. Simulations have been completed using MATLAB Simulink with evolved topology and observed that the developed topology presents the higher quantity of THD and additionally there may be growth within the fundamental voltage significance which suggests proper performance. PV array and boost converter is modeled and its overall performance is analyzed. Also the 7 level inverter is simulated with the PV array as its input and determined to be precise performance were observed in [6]. It presents a literature survey of FACTS technology tool and application for power quality and efficient renewable energy system utilization in [7]. New trends in power electronic technology for the integration of renewable energy sources and energy storage systems are discussed in [8]. Measurements for active filter in addition to the behavior of inverter systems with UPS capability at some points of grid faults wherein mentioned on the end of utility side. Under without APF the overall harmonic distortion is 32.8% and by means of usage of APF in a DG unit the THD is decreased around 10.2% in non-linear masses. Via the usage of series APF, the THD value nearly decreased around to 9.5% in [9]. Photo voltaic – fuel cell combination system comprises a PV panel. A battery bank was linked to the DC bus. Energy is present in way of the battery if it is present in charged condition the fuel cell will be became off. In this situation the battery supplies the energy to the load. It was validated via virtual test bed (VTB) discussed in [10]. A technical evaluation of power quality problems and the way the custom devices used to enhance the PQ in grid related renewable energy systems at the point of common coupling had been discussed in [11]. The overall performance evaluation of a shunt active filters with VSI topology the usage of synchronous frame principle in the grid connected PQ panel were mentioned. It reduced the harmonic level at the point of common coupling for 3.94% with the aid of the use of shunt active filters [12]. Technique of calculating the optimal size of a stand-alone hybrid solar-wind-battery system is presented in [13].

III. INTEGRATION TECHNOLOGY

Hybrid power system is a combination of solar and wind renewable energy. There are specifically kinds of technology is used for grid integration of solar and wind power.

A. Wind Turbine Technology

Wind turbine makes use of the variable-velocity turbines as their annual energy seize is set 5% more than the fixed-speed era, and the active and reactive power issues also can be easily handled however it wishes an extra energy converter.

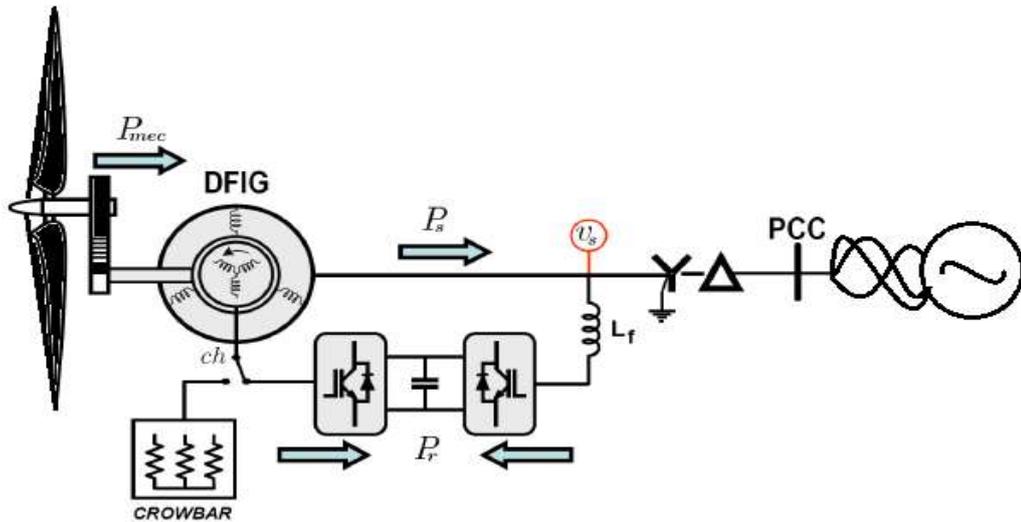


Fig2: The doubly fed induction generation (DFIG) [5]

- *Variable speed concept using doubly fed induction generator (DFIG):* In this converter feeds the rotor winding, even as the stator winding is attached directly to the grid in a variable –speed turbine with DFIG. Permits a vector control of the active and reactive powers of the device, and a decrease via a high percentage of the harmonic content injected into the grid.
- *Variable-speed concept utilizing full-power converter:* The energy from the generator is rectified to a dc link and after is transformed to a appropriate ac power for the grid by means of a three phase converter.
- *Semiconductor device technology:* Power semiconductors with better electrical traits and decrease prices are used.
- *Variable-speed concept using permanent magnet synchronous generator(PMSG)*

B. PV Technology

The photovoltaic (PV) energy is the most promising source of energy considering it is pollution unfastened and abundantly to be had anywhere within the world. PV energy is specifically useful in faraway sites like deserts or rural zones where the difficulties to transport fuel and the lack of energy grid lines make use of conventional assets are not possible. PV systems as an alternative energy useful resource or an energy resource complementary in hybrid systems were turning into feasible because of the growth of research and improvement work on this region. A good way to maximize the success of the PV structures, a high reliability, an inexpensive value, and a consumer- friendly layout should be carried out in the proposed PV topologies. Converter is used to transform dc power of PV into ac and also to inject power to the grid.

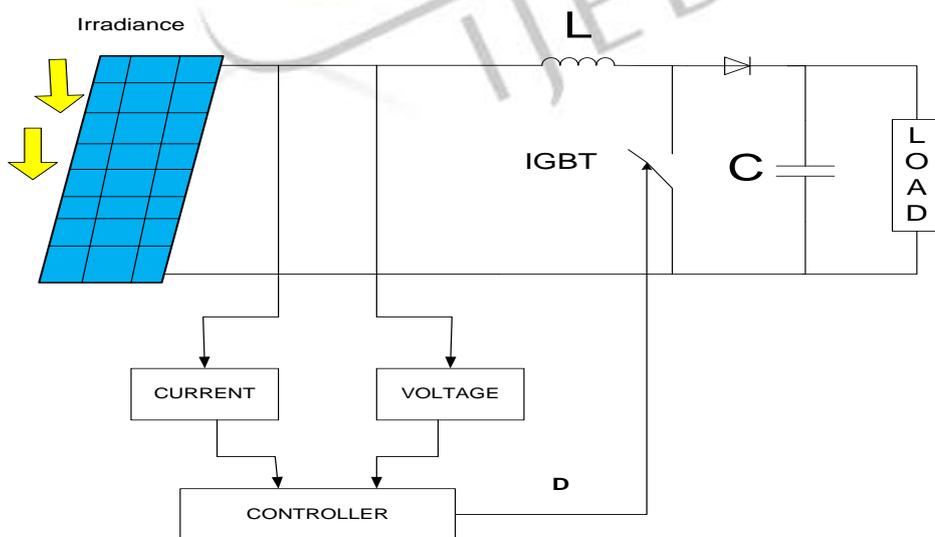


Fig3: Diagram of PV system [2]

IV. POWER QUALITY ISSUES

Power quality problems such as voltage regulation, flicker, harmonic distortion, stability etc. are occurs at the time of integration with the existing grid. These power quality issues are to be confined to IEC and IEEE standards. Some of them are given below-

Table 1.

Issues	Causes
Voltage Unbalance	Large single phase loads, incorrect distribution of all 1phase loads by the three phases of the systems
Voltage Interruptions	Arc furnace, repeated start/stop of electric motors such as elevators, oscillating loads
Voltage Sag	Faults on the electrical networks, faults in consumers installation, start-up of large motors and connection of heavy loads
Voltage Swell	On/Off of heavy loads, badly dimensioned power sources, badly regulated transformers during off peak hours
Harmonic Distortion	Modern sources, all non-linear loads such as power electronic devices , SMPS, data processing equipments
Short Interruption	Opening and automatic recloser of security equipments to decommission a faulty part of the network
Long Interruption	Material failure in the electrical network, storms, human error, failure of security equipments

Power system Stability concerns the different types of stability problems including “Rotor angle stability”, “Frequency stability” and “Voltage stability”.

V. POWER QUALITY MITIGATION SCHEMES

A) *A Using Multilevel Inverter*

The multilevel technique synthesizes the AC output terminal voltage with low harmonic distortion, thus reducing filter requirements. The output voltage waveform of a multilevel inverter is composed of the number of level of voltages, as the number of levels reach infinity, the output is a pure sinusoidal. Recently H-Bridge multilevel inverter is used for improvement of power quality due to reduced cost and switching losses.

B) *Application of FACTS devices*

The main objective of FACTS devices are to increase the usable transmission capacity of lines and to control the power flow over designated transmission routes. FACTS devices are also used to improve the power quality. These are static VAR compensator (SVC), dynamic flow controller (DFC), thyristor controlled series compensator (TCSC), HVDC back to back. Unified power flow controller (UPFC), static synchronous series compensator (SSSC), static synchronous compensator (STATCOM), and dynamic power flow controller (DPFC).

C) *Using Series Active Self tuning Filter*

Grid interface inverter acts as hybrid series active filter (HSAF) with Synchronous Reference Frame (SRF) method employing Self Tuning Filter (STF) to mitigate problems related to voltage unbalance and harmonics in voltage at the grid side.

D) *With application of UPQC (Unified Power Quality Conditioner)*

In this performance of UPQC is improved by fuzzy logic controller. Fuzzy controlled UPQC provides effective and efficient mitigation of both voltage sag and current harmonics than the conventional PI controlled UPQC.

VI. CONCLUSION

In this review paper, all the power quality issues have been addressed. The common and future traits for renewable energy structures were described.

Grid integration and power quality problems of wind and solar energy system and their viable solutions available inside the literature. The reasons, influences, mitigation techniques of the solar and wind energy system are presented.

Power electronic devices are the feasible solution to limit the fluctuations and intermittent problems of the grid integration. Many researchers had identified various power quality issues and their causes regarding power quality in Table 1.

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