Distributed Power Generation Systems (DPGS) and its grid integration

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Abstract:

It gives basic idea of the current status of power system and the future trends, importance of the renewable Distributive Power Generation System and its grid integration. Further its also tell about the role of power electronic in the grid integration of DPGS.

Introduction:

Energy is the basic building block of economic development of any country. Electricity is the most flexible form of energy that constitutes one of the vital infra-structural inputs in social-economical development. Approximately 67.8% of the India's total installed capacity is contributed by the conventional energy resources which mainly based on the is fossil-fuel based power plants.

Modern home appliances,lights,computers,pretty much everything that uses electricity uses it in the form of alternating current (AC) electricity. The renewable energy mostly found in DC form. This DC form has to be converted into AC form or your electrical devices will not be able to run. An inverter is an electrical device that performs the conversion. Next to the panels, it is the second-most important part of a solar energy system. For variable frequency and variable voltage applications such as single phase induction and three phase induction machine and rotating machines to vary the supply frequency and voltage VSI is used.

To ensures the correct operation of current controllers the important key component is the technique used for generation of reference current signals. The calculation related to the estimation of reference signal based on the collection of correct information of the system, by the detection of the voltage or current signals. The voltage variables which are to be sensed are the DC bus voltage and the ac source voltage to be needed and the current variables to be sensed are the DC link current, compensation current, and the AC source voltage. The estimation of reference signals is carried out in terms of voltage/current levels are estimated in time/frequency domain based on the system feedback and variables.

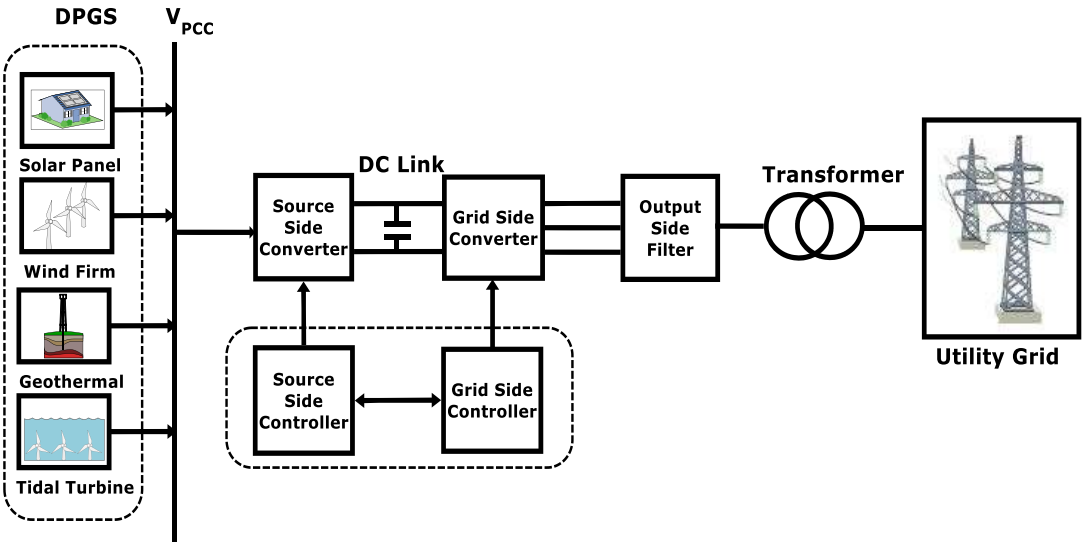
Motivation

The insufficiency of energy in now a days has affected the economics, society, development of nation and environment. Conventional energy production causes emission of green house gases, pollution on other hand

renewable energy sources are more environmental friendly. It reduces toxic buildup and harmful smog present in the air and water, it also minimizes the impact caused by the coal mining and gas extraction. But replacement of our fossil-fuel infrastructure is a time taking process and at the same time we will have to meet the raising demand hence it is required to build renewable energy generator along with the convention power generators.

Distributed Power Generation Systems (DPGS)

DPGS technologies include both renewable and non renewable sources. DPGS from renewable energy is at gaining much importance as we are more concerned about the potential global warming climate change and our main effort is to find an environmentally friendly solution for the energy crisis. In the last decade, technological innovations and changing economic and regulatory environment have resulted in a renewed interest for distributed generation. This is confirmed by the IEA (2002), who lists five major factors that contribute to this evolution, i.e. developments in distributed generation technologies, constraints on the construction of new transmission lines, increased customer demand for highly reliable electricity, the electricity market liberalization and concerns about climate change.

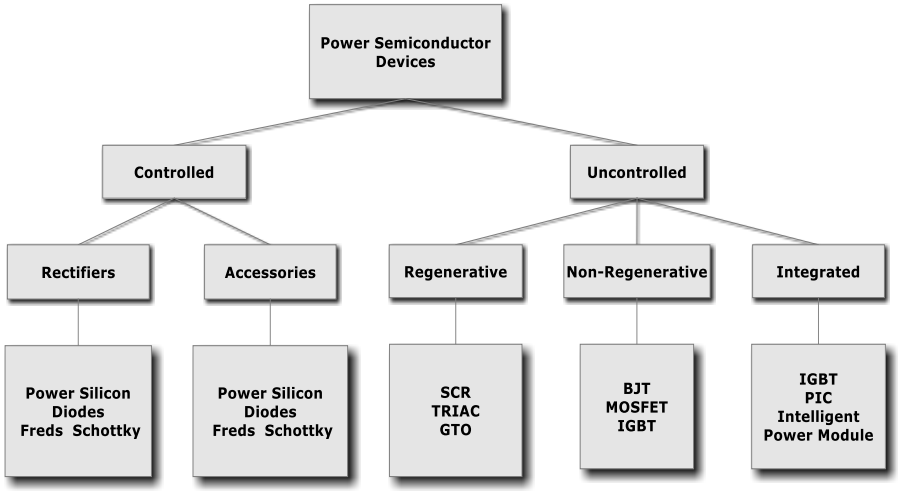


Benefits of DPGS integration with utility grid

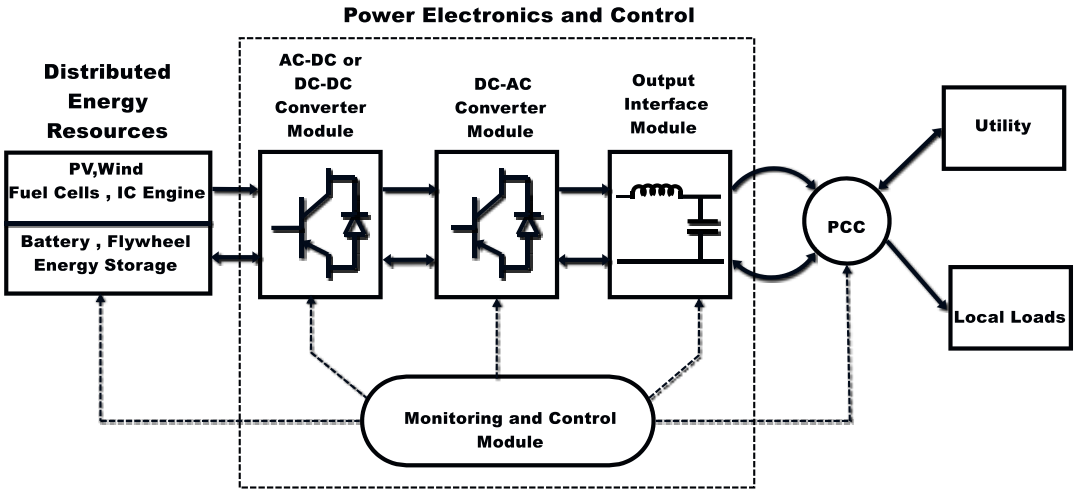
I. Reduction in distribution and transmission line losses
II. Accessibility to the remote areas
III. Rural electrification
IV. Supply reliability and power quality
V. Independent systems
VI. Upgrading Electrical market

Concept of power electronic control

MOSFET, GTO, IGBT, etc. The development of power semiconductor devices has always been a driving force for power electronics systems The development of power semiconductor devices has always been a driving force for power electronics systems



Importance of Power Electronic Devices



Based on various renewable resources, this DGS consists of solar PV, wind and biomass biogas power generations, storage devices, power electronic converter devices, energy monitor and management system, loads and transmission lines. Each distributed generation unit goes through inverter, filtering and transmission lines to supply for the local loads directly or into the point of common coupling (PCC) to connect the power grid.

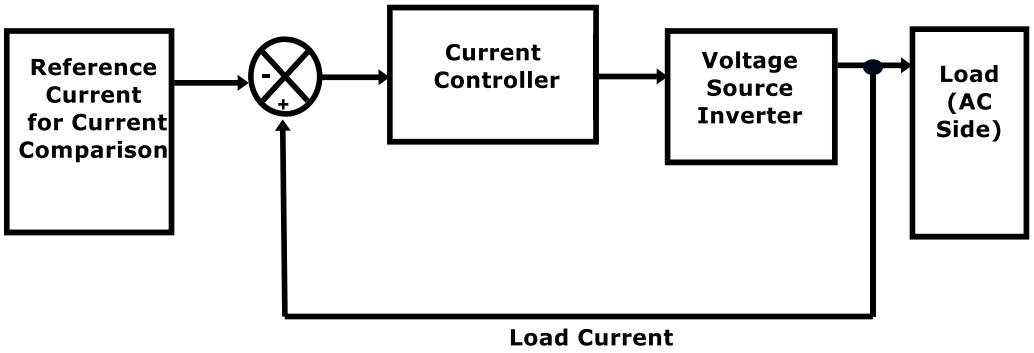
For different distributed energy (DE) systems different type of power electronic topologies are used fro the conversion of the output power of the distributed generator to utility compatible power. Beside this they also have other inherent advantage such as improvement of operating efficiency and power quality, volt-amperes reactive (VAR) support and voltage regulations, and the reduction of distributed energy fault currents

Why Pulse Width Modulation Voltage Source Inverter (PWM VSI) ?

The growth in applications of the three-phase voltage source inverters lead to a need of highly flexible algorithm for inverter modulation control. Output voltage of an inverter can be controlled by exercising a control within the

inverter itself. The most efficient and effective way of doing this is by using pulse width modulation control technique with an inverter itself . In pulse width modulation (PWM) control method, a fixed dc voltage is given to the as the input to the inverter and the output voltage is controlled by adjusting the on and off periods of the inverter components. .

Pulse width modulated inverter are popular for many application such as high power factor ac/dc converters, active filters, ac motor drives and uninterruptable power supply. The current controlled PWM (CC-PWM) offers high accuracy and better instantaneous current waveform control in comparison to the open loop voltage PWM converters.



Modulation also produces an instantaneous deviation of the current from its average value as an effect of voltage harmonics. The deviation amplitude depends on the duration of the modulation period, the supply voltage, the ac side average voltage and the load parameters [20]. With reference to the basic requirements, the accuracy of the current controller is evaluated. Some important requirements of the current controller includes low harmonic contents, good dc link voltage utilization, no phase and amplitude errors, and a limited or constant switching frequency for safe operation of the switching power devices.

Pulse Width Modulation Technique

The Pulse Width Modulation (PWM) technique is one of the most popular new techniques, which can be implemented for the harmonic reduction of inverters. PWM Principle: Because an inverter contains electronic switches, it is possible to control the output voltage as well as optimize the harmonics by performing multiple switching within the inverter with the constant dc input voltage Vd.

. The fundamental voltage V1 has the maximum amplitude (4Vd/π) at square wave, but by creating two notches as shown the magnitude can be reduced. If notch widths are increased, the fundamental voltage will be reduced.

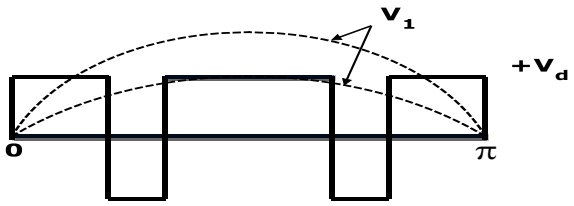


Figure 1.1 PWM Principle Control Output Voltage

Figure 1.2

The classifications of PWM techniques can be given as follows:

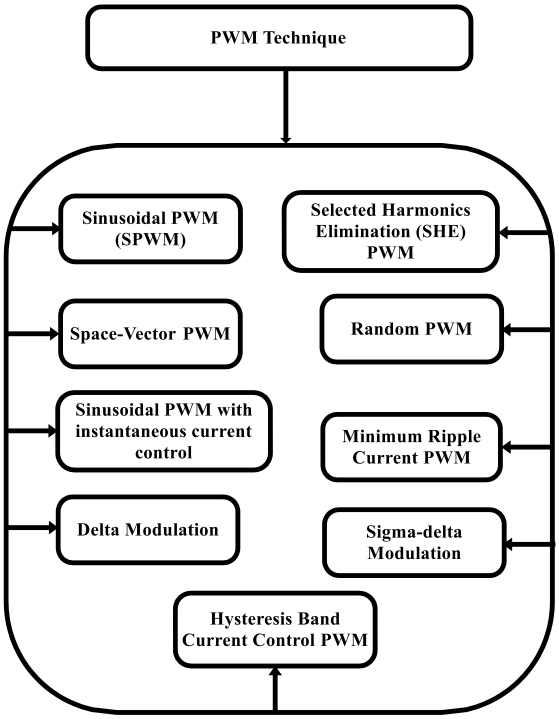


Figure 1.3 Different types of PWM Techniques

. This is the most efficient method of controlling the output signal by controlling the width of the pulses. Advantages of PWM technique [23]:

- When used in the inverters, the output voltage control can be obtained without any additional component.
- With this type of control, lower order harmonics can be minimized or can be eliminated

Research Objectives

The overall objectives to be achieved in this study are:

1. Analysis and Implementation of Band Hysteresis Current Controller (HCC), Double Band Hysteresis Current Controller (DBHCC), and a New Hysteresis Current Controller for a single phase grid connected VSI in steady and transient condition.
2. Verification of the behaviour and performance of Hysteresis Current Controller (HCC), Double Band Hysteresis Current Controller (DBHCC), and a New Hysteresis Current Controller for a single phase grid connected VSI in MATLAB-Simulink environment.
3. Validation of simulation result of Hysteresis Current Controller (HCC), Double Band Hysteresis Current Controller (DBHCC),and a New Hysteresis Current Controller for a single phase grid connected VSI.

4. A comparative evaluation in terms of THD, Output current ripple and switching frequency between Hysteresis Current Controller (HCC), Double Band Hysteresis Current Controller (DBHCC), and a New Hysteresis Current Controller for a single phase grid connected VSI.

Conclusion

In the paper " Renewable Energy generation in India Present scenario and future prospects" authored by S.N Singh et.al.[1], in this paper author discuss about the importance of renewable energy how it can play an important role in the development of a country in the present scene of the increasing energy demand, due to the depletion of fossil fuels, and raise in the price of fossil fuels, around the globe and also in the need of the reduction of CO_2 emission level.

In the paper " Distribution generation: Definition, benefits and issues " authored by G.Pepermans et.al.[12], in this the author observed the renewable energy scope in the small-scale electricity generation and gives a brief survey of existing small-scale technology and the benefits and issue regarding the small-scale electricity generation.

In the paper " Benefits of Power Electronic Interface for Distributed Energy Sources " authored by Kroposki,B et.al [4], in this paper the author mentioned the different distributed energy resources and their power electronic interface, also the benefits of the power electronic interface.

In the paper entitled " Single Phase Active Power Filters for Non Linear Loads " authored by David A.Tarrey et.al [8], in this paper the author proposed a methodology to compute the reference current.

In the paper entitled " Application of Voltage and Current Controlled Voltage Source Inverter for Distributed Generation Systems " authored by Sung Hun Ko et.al [3], in this paper the author discuss about the popularity of the VSI in different applications, including DG system and benefits of VSI and again a detailed comparison is carried out between Voltage control VSI and Current Control VSI for DG application.

In the paper " The factor Affecting the Performance of Solar Cell " authored by Bhalchandra V. Chikate et.al [5], in this paper the author talks about the different renewable energy resources, advantage of the solar energy in different aspects, and the impact of the different factors over the solar cell performance.

In the paper entitled " A Hysteresis Current Controller for Single Phase Full Bridge Inverter " authored by Pekik Argo Dahono et.al [6], in this paper different current controller and their advantages and disadvantages of the HCC and DBHCC is discussed and a new hysteresis current controller is proposed to migrate the disadvantages of th HCC and HBHCC.

In the paper " Modified Hysteresis Control with Minor Loops for single phase full bridge inverters " authored by Toshiji Kato et.al [10], in this paper th demerits of HCC is discussed and the advantage of the modified hysteresis current controller is analysised.

In the paper entitled " New hysteresis Current controller for single phase full bridge inverter " authored by P.A.Dahono et.al [9], in this paper the author discussed about HCC, DBHCC, and new hysteresis current controller and analyzed that the superiority of new hysteresis current controller over the HCC and DBHCC.

In this paper " An adaptive hysteresis band current controller for shunt active power filter " authored by Murat kale et.al [11], in this paper an adaptive hysteresis band current controller is proposed for active power filter to eliminate harmonics and to compensate the reactive power of three-phase rectifier

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