Issues and Challenges in Integration of Renewable Energy in Grid

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Abstract: With increase in demand and due to non-availability of fossil fuels in future, the world is progressing towards the renewable energy target for their electricity supply.According to the Ministry of New and Renewable Energy (MNRE) , India has 23.39 % renewable energy share in the total generation installed capacity i.e. 368.98 GW up to29th February 2020[1] The world's largest expansion renewable energy program is to achieve 175 MW till 2022. Power system planning and operation engineer has to make certain changes to meet these targets.The purpose of the grid integration is to deliver variable renewable energy in efficient manner to grid. [2] However the numerous issues related to grid integration of renewable energy sources should be taken care and there is a need to find thepossible solutions for these issues. In this paper,a reviewabout the various issues, challengesin renewable energy integration with some possible solutionsis presented.

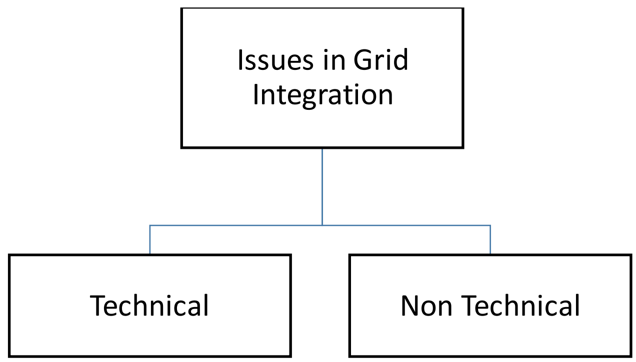
***Keywords**:*VRE, grid management,PV,VSM, RES

1. INTRODUCTION

Because of the ecological concerns and depletion of fossil fuels, renewable energy use is increasing drastically specific in case power generation. Renewable energy source integration to utility grid depends upon the scale of power generation that can be large scale(connected to transmission system) or small scale generation(connected to distribution network). Due to the random nature of renewable energy sources their integration into grid is quite cumbersome.[2].The difficulties occur due to interconnection of various equipment's such as generator, transformers, transmission line and load in power system network. The loading effect of transmission line is minimized due to distributed generation. . Renewable energy sources are used as distributed generation in micro grids.The merits of RES are low greenhouse gas emission [2], sustainability,ecofriendly[3],low maintenance cost etc.Penetration of renewable energy affects the local market price as well as reduce the tariffs of adjacent interconnected system. Renewable energy high penetration causes certain difficulties.[12,13]There are numerous sources of producing power using alternative energy sources such as solar energy, wind, geothermal,tidal , biomass etc. In this paper the issues and challenges posed by solar and wind energy system is discussed in detail with some possible solution.

2. ISSUES IN GRID INTEGRATION

The issues in grid integration can be categorized as technical issue and non -technical issue



2.1 TECHNICAL ISSUES

(i) Power quality Issues:
High level of penetration of wind energy in distribution system poses menace to the network with respect to issues related to power quality such as harmonics , voltage fluctuations and frequencyvariation.[3]The uncertain nature of the wind energy in wind plants generates fluctuations in power which have negative effect on stability and power quality. [13]In wind power plants, the problem of flickering can be caused due to the disturbances in wind speed. The impacts of integration of distributed generation on power quality cause (is) Dips and steady state voltage rise (ii) harmonics (iii) voltage flickers. High penetration of wind energy also cause stability problems that is the reason why wind penetration is limited by available transfer capability (ATC). Moreover frequency of system also depends upon wind penetration. Thus high penetration wind energy can reduce the overall efficiency and degrade the power quality .Apart from this, the power electronics converters used in interfacing with AC grid in photovoltaic system causes harmonic distortion in the system.Harmonic currents drawn from nonlinear load and reactive power control is not possible to manage by grid connected PV system.

(ii) **Frequency variations**

Due to the non-synchronous generation of PV systems, the frequency of system cannot be maintained constant.As there is no inertia in photovoltaic system, so there is need of additional devices to stabilize the frequency oscillation. Marinating constant frequency is mandatory for the grid because with the change in frequency the active power generation is affected. [1]

(iii) Over generation

The conventional power plants (coal or natural gas) can turn off and on usually to accommodate the changes in variable generation due to presence of additional renewable power on grids.[2,7,8]Due to this it becomes difficult to realize the full energy value of photovoltaic system. Hence the change in net load linked with high midday photovoltaic generation and low electricity demand cannot be accommodated easily. These type of situations can create "over generation" conditions.To avoid over generation, wind output and PV can be curtailed. This can be achieved by either lowering down the output from inverter or turn off the plant. This is only possible if plant operator has control over generation. This can be possible for large renewable power plants but it is not possible in case of rooftop photovoltaic system.

(iv)Stability issues

The significant difficulties of coordinating PV at high penetration include the necessity tomaintain stability of grid when system undergoes to some kind of disturbance.Its impact on frequencylinked with high instantaneous penetration of variable generation is one of the major concern. [13]In this way wear and tear on the units expanded because of this sort of cycling of fossil-filled generators which lead to decrease in efficiency.

(v)Communication issues:
Communication with loadcanters of specific area is required to maintain the reliable service and uninterrupted supply of power with respect to base load, maximum load and load factor.Due the weather changes the power generation due to solar and wind energy is affected, so it becomes difficult to do communication Thus for this purpose , there is need to install the efficient communication devices and network which maintain the balance between the requirements of conventional as well as non-conventional sources.

(vi)**Accuracy**
Due to uncertain availability of solar energy the output of PV systems cannot be predicted with accuracy, so according to demand the generation needs cannot met.

(vii) Protection Issues

PV systems inject current into grid instead of regulating the voltage. The abnormal utility conditions detected by power system protection devices is decided by the operating range of voltage of PV inverters.The utility voltage can be affected if the current injection due to PV system is of large magnitude. The PV current injection should not be more than the load on the line. If this happens, the utility voltage regulation devices does not operate in efficient manner because these regulation devices does not have capability of current sensing directionally.The operatingappropriate voltage range for interconnection of solar PV system can be chosenbetween the range of 88% and 110% of the nominal voltage.

2.2 Non-TechnicalIssues

(i)Non availability of technical skilled workers.
(ii) Change in Weather due to which availability of RES is not predicted

3. Addressing the challenges of Renewable energy integration

3.1 Advance Forecasting
The uncertainty of variable renewable generation can be reduced by the advance forecasting of solar and wind powerforecastinghelps in accommodatingthe changes in wind and solar generation according to the demand and supply equilibrium. Due to this, amount of operating reserves can be reducedand thus overall cost also reduces.

3.2 Virtual Synchronous Machine

The integrated PV micro grids transient stabilitycan be improved by adding inertia and damping in the system by inserting virtual synchronous machine. A virtual Synchronous machine can create virtual inertia by using small amounts of energy controlled device by a power electronics converter in photovoltaic systems [14,15].The batteries, super-capacitors etc. can serve the purpose of energy storage. The energy storage element reproduce the inertial and damping properties by injecting or absorbing active power from grid in a similar manner as synchronous generator do by the injection or absorption of kinetic energy. The block diagram of VSM is shown below in Figure (1)

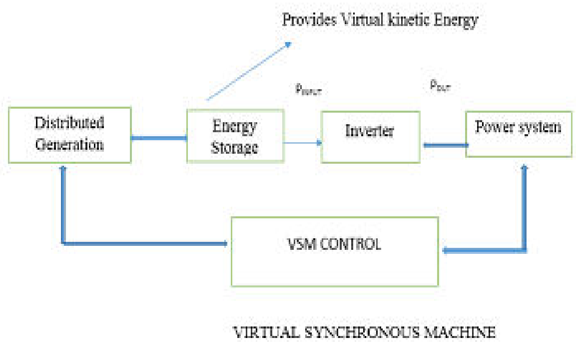


Figure 1:Virtual synchronous machine Block diagram

By utilizing these concepts, dynamic frequency control can be maintained and thus frequency variations can be reduced. [16]

3.3 Fast Dispatching

To manage the uncertainty of renewable generation, fast dispatching can prove helpful. There is no need to regulate the resources if fast dispatching can be done and thus it improves the efficiency and helps in maintaining the balance by proving broader access to resources. [7] Generally the generators are scheduled according to standard practice i.e. generators have set schedules on hourly basis and thus generators are not available for maintaining balance in case of schedule deviations. Fast dispatching can reduce the need of expensive regulating reserve as the load and generation levels can be matched easily with it and most economical resources are utilized for efficient balance within the system.

3.4Reserve Management

To reduce the substantial cost savings, there is a need to modify the reserve management practices.Uncertaintycan be controlled by putting constraints on wind energy ramps which further lead to reduction of reserves and allow variable renewables to make available the reserves or other ancillary services. Putting limits on wind generation and wind output changes can remarkably lowerdown the need for balancing reserves, yielding cost saving as the reserve are set to address relatively low probability [2, 7] To maintain a proper balance between demand and supply,integrating variable renewable generation sometimes helps in cases of fast ramps or severe event .Demand side management provide reserves and ancillary services as well as peak reduction. DSM programs can strengthen transmission and distribution network by reducing the energy costs for utilities. Thus in long term, the requirement of more generation capacity can be limited.

3.5 Power Balance:

Integrating RES with energy storage unit is one of the best way to create power balance.

The flexibility can be added by integrating storage into the utility grid. [11]Thus it will help the utility grid to cope up with increases in renewable energy generation penetration in future by acting as a bridge, and a reliability component.

3.6 Flexible Generation Sources

With the use of flexible generating sources, it is easy to accommodate solar and wind power with flexibility in network. Theresilience in generation sources can be estimated by their ramp rates, output control range, and response accuracy. Apart from this minimum run times and off times, start-up time, and minimum generation level also play significant role in flexibility of renewable generation.Coal and nuclear plant operated as base load units are least flexible whereas the hydropower, combustible and internal combustion engine are most flexible. The ability to ramp up or down quickly in steam power plants is limited because it has sufficient amount of thermal inertia in boiler. [1]

3.7 Flexible Markets

Wind and solar energy have near to zero marginal cost. Hence when they became a part of a market dispatch, by and large energy prices will reduce. In spite of the fact that there might be a bit of scope for customers, there are inquiries concerning the sustainability of this sort of market since certain generating units may acquire deficient income to extend their variable and as well asfixed cost. This has prompted great interest in capacity markets. [7, 8]Another worry is, will it be possible for energy markets to provide adequate incentives to generators to act in an adaptable way even with quick economic dispatch. The energy markets can be supplemented with a ramping product called “flexi-ramp” The goal is to guarantee adequate ramping capability,and this may be possible by changing the set points of dispatch of certain generators to guarantee the flexibility.

4. Conclusion :

Sustainable energy is one of the important parameter in economic growth of a country. High penetration level of renewable energy sources into grid has increased recently which further leads to many issues such as power quality,stability,over generation and protection problems. In this paper, numerous issues has discussed while integrating renewable energy resources into a grid. Although integration of renewable energy poses certain challenges in integration with grid but these alternative sources can be said as the future of coming power industry as these are the ecofriendly sources. It is suggested that utilizing new and innovative solutions can mitigate the challenges of variable renewable generation integration, at least in some cases (such as using fast dispatching, VSM techniques etc.) with significant cost savings compared to traditionally used integration techniques.

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