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Grid Integration of Renewable Energy Sources

Syed Awwab Tausif[1], Lokesh Garg[2]

[1, 2]Galgotias University, Greater Noida, U.P. India
Email: syed.tausif01_2017[at]galgotiasuniversity.edu.in, lokesh.garg[at]galgotiasuniversity.edu.in

Abstract: ***Demand for renewable energy has increased due to increased environmental awareness and conservation concerns. Renewable energy has been shown to be more efficient in the production of electricity. The wind and solar systems of PV have shown a significant growth rate over the years and are capable of grid integration. However, integrating all renewable energy sources is not easy because all renewable energy sources are available in a distributed manner. The older generations are connected to transmission systems and younger generations are connected to distribution systems. Here we discuss some of the problems that arise during the integration of these resources and other solutions on how to fix them.***

Keywords: Renewable energy, Power Grid, Solar Energy, Wind Energy, Energy control, Energy quality, Protection

1. Introduction

Consumption of renewable energy sources (RES) is growing rapidly due to the sharp decline in fossil fuels and associated environmental problems. It is a challenge to integrate RES into the natural energy grid infrastructure as many renewable energy sources are short-lived in the environment. New efforts have to be undertaken for the management of energy networks, integration of RES in the distribution networks, for generation and load. A 500% increase in global energy production from renewable energy.

Table I: RE based Power Generation Capacity by 2016

Resource Type	Capacity (GW)
Hydro power	1096
Wind power	487
Solar PV	303
Bio-power	112
Geothermal power	13.5
Concentrating solar thermal	4.8
Total RE Generation Capacity	2017

As most of the renewable energy sources are intermediate from time to time it therefore becomes a challenging task to integrate the RES into the power grid infrastructure. This trend leads to many technical and non-technical challenges. In order to maintain reliable and cost-effective availability, new efforts should be made for energy network management, integration of RES in distribution networks, production and load management and a range of other technological and social and economic aspects distributed by energy markets. Increased penetration rates for PV and wind systems increase concerns over other resources due to the potential negative impacts of power fluctuations made on these systems on network performance. Also, fluctuations in the power of these systems can lead to unstable operation of the electrical network prior to faulty conditions, high power outages to suppliers and unacceptable power outages in certain areas of the power network. In addition, the random variability of the power output generated by these systems does not allow for consideration in the power generation planning system.

2. Overview of renewable energy sources and their grid connection

2.1 Wind Turbines

A turbine generator (WTG) converts wind kinetic energy into electrical energy. WTGs are generally classified as wind turbines (VAWT) and horizontal wind turbines (HAWT). In VAWTs, the wind blades rotate around the vertical axis and in HAWTs, the blades rotate around the horizontal axis. Larger modern WTGs use a horizontal axis formation. The maximum power (Pm) emitted by WTG is given as

$$P_m = ½\, \rho A U w^3 C_p (\square, \beta) \quad (1)$$

where, ρ: air density, A: rotor sweep area, Uw: wind speed, Cp: power coefficient, λ: tip speed ratio, β: pitch angle.

It can be seen from (1) that in order to increase the exhaust air flow, (a) requires high wind speeds, and (b) long steel lengths. Since WTG power output is equal to the cubic force of wind speed, a small variation in wind speed can cause a significant change in its output. WTGs can be in the speed range (FS) or speed (VS) type. VS-WTGs work better than FS-WTGs. FS-WTGs use a cage induction generator, which is directly connected to the grid. In a wide range of speed controls, WTs are integrated with the Doubly-Fed Induction Generator (DFIG), shown in Fig. 1, or Permanent Magnet Synchronous Generator (PMSG) with multiple characters, shown in Fig. 2. WTG power output as a wind speed operation is shown in Fig. 3.

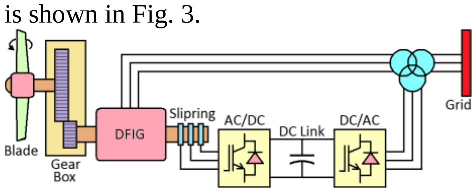

Figure 1: DFIG based wind turbine

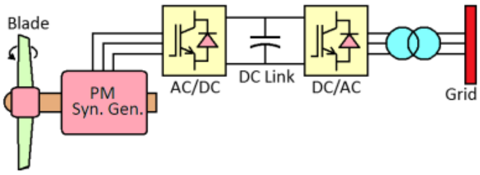

Figure 2: PMSG based wind turbine.

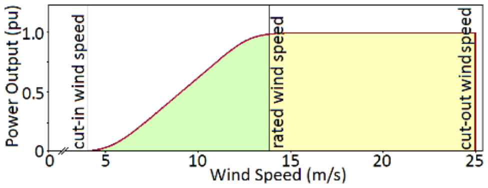

Figure 3: Wind speed vs. WT power output.

I) DFIG based WTGs

DFIG is a wound rotor induction generator with the three-phase stator winding is directly connected to the three phase grid and the three-phase rotor winding is fed from the grid through slip rings, linking the rotor and grid through a bi-directional ac dc ac converter. Since the DFIG rotor voltage is less than the stator voltage, the transformer connecting the machine to the system has two secondary windings; one for the stator and the other for the rotor.

II) PMSG based WTGs

The wind-driven PMSG uses the full range of dynamic power ratings in its stator circuit grid connection. Permanent magnets are used in the Rotor to provide interest. Due to full-scale converters, the speed control of these WTGs is much wider than the standard converters based on DFIG-WTGs. By using a large multipole rotor, these wind turbines can be directed directly to the power generators without the lifting gear.

2.2 Solar Photovoltaic (PV)

A photovoltaic cell is a semiconductor device that converts visible light into electricity. PV cells are made up of one or more p-n compounds. When light falls on a PV cell, it produces a voltage as a function of light energy. The cell is the basic building block of a PV power system with an output power of approximately 0.5 V at the current level of 8 A to 9 A. To achieve the highest power, many such cells are connected in series and are matched to form a module. A photovoltaic array is a complete power generating unit, containing a large number of PV modules. The performance of a solar PV cell is shown in Fig. 4, its current power supply (IV) and power voltage are shown in Fig. 5 and the PV-based power generation system is shown in Fig. 6. Solar panels usually operate near the MPPT curve (maximum point tracking) for maximum energy exposure to sunlight.

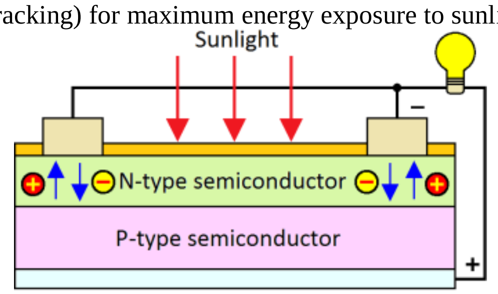

Figure 4: Block diagram of a PV cell.

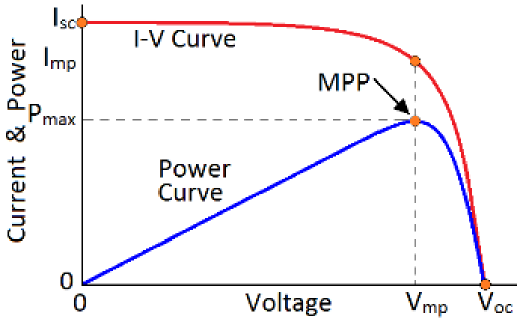

Figure 5: I-V and power curves.

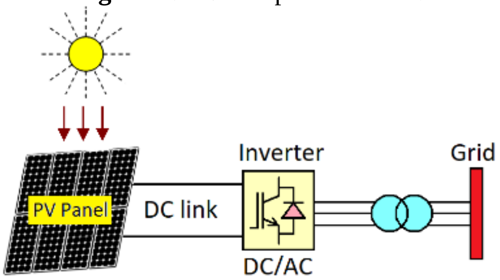

Figure 6: PV based power generation

2.3 Hydro Energy

Hydro energy is the largest renewable energy source to date and is used for hydroelectric power. Hydro energy is widely used worldwide and contributes to about 16% of global electricity production. Potential energy from falling water is converted into mechanics by hydel turbines that control alternatives to generate electricity. Hydel power plants operate at high efficiency due to small power losses during the conversion process. Hydro power plants are usually divided on the basis of power such as large scale, small scale and small hydel power systems. Production methods also vary depending on the availability of water resources and the necessary electrical requirements including conventional water dams, final storage technology and river plants. Small and medium-sized hydel plants are widely used due to their rapid response to a wide range of operating conditions, few environmental impacts and minimal investment required. The energy released from the moving water is determined by relation as follows

$$P(t) = \rho g Q h \qquad (2)$$

Where, ρ; density of water in kilograms per cubic meter, Q; discharge in cubic meters per second, g; acceleration due to gravity, h; height difference between inlet and outlet.

2.4 Geothermal Energy

Geothermal energy is generated using heat generated from the earth's crust. The heat dissipation process requires the distribution of liquid to the ground by a heat exchanger where it is used for power generation or for direct heat applications. The geothermal power system works in much the same way as conventional thermal plants except for the production of smoke from geothermal energy which is the result of deep chemical and environmental processes in the earth. However, the efficiency of these plants is much lower than that of tropical plants due to the low temperature of the stream formed. Geothermal energy production can be estimated by the following relationship

$$P\,(MW) \approx (C_p * F * \Delta T * \eta) - p \qquad (3)$$

Where, P(MW); Output Power Obtained in megawatts, Cp; Specific heat of the working fluid, F; Flow rate from the production well, ΔT; Extracted sensible heat (TReservoir – TExtracted,) η; Efficiency with which the heat energy is used, p; Parasitic losses

3. Challenges faced while integration of res

An electric power system is a network of electrical components comprising generators, transformers, feeders, and protection and load devices; used to produce, transmit, protect and harness electrical energy. Traditionally, power system networks are designed in such a way that active energy (P) and active energy (Q) flow from high to low levels, that is, from the transmission network to the distribution system; and from there it is still distributed to customers. This is a standard radial system, represented by a single voltage source for each distribution supply. Due to the lack of connected generators, distribution systems are called inactive circuits. However, with the introduction of renewable energy generators, the situation will return. There will be multiple power sources in one feeder. With a significant level of RE-based generators connected to the distribution level, the power flow in the region can be changed and the distribution network is no longer an idle circuit distributing loads. Depending on the volume of the product, the grid integration of renewable systems can be done by transfer rate (large volume) or distribution rate (small volume). Currently, most RE programs are connected at the LV distribution level.

The technical issues that need to be addressed while integrating RE resources on the distribution system are:

- Point of common coupling (PCC) and Voltage level
- Voltage variations & Power quality
- Voltage ride-through capability
- Reactive power compensation capability
- Frequency regulation capability
- Protection issues

3.1 Point of Common Coupling

PCC is a point on the grid where many generators and loads are connected. The importance of PCC is that it is a point in the network where the generator will cause a lot of disruption. According to IEEE Std. 519, PCC should be a point that is accessible to both utility and customer so that measurement can be done directly. RE variability is due to power variability in PCC. The basic requirement to connect a generator to the power grid is that in the event of a fault, it should not adversely affect the level of power provided to customers. Grid power measured in PCC by short circuit errors can absorb without disrupting the entire system. The power of the grid reflected in the short circuit scale (SCR) is defined as

$$SCR= \qquad (4)$$

Where, S_{sc}; short circuit capacity (MVA) on the bus where a generator is available, Pg; producer average (MW), (Ssc); maximum power that can flow to a network in the event of a short circuit. It represents the node strength to transfer power in a stable condition. It is represented as

$$S_{sc} = If\, V_s = Vs = \frac{^2}{} \qquad (5)$$

where, If = fault current, Vs = grid voltage, and Zs = grid impedance.

Substituting (5) in (4) we get

$$SCR = \frac{^2}{} \qquad (6)$$

A network may be considered strong with respect to the RE integration, if SCR is above 10 and weak if SCR is below 10. It is obvious from (6) that a network will be strong if the operating voltage is higher and the effective impedance is smaller. From a stability point of view, a new generator connected to a strong point in the grid (i.e. bus with a high fault level) will have less trouble exporting power, than the connection of the generator to a weak point (low fault level) in the network. In case of a weaker grid, the flow of active and reactive power into and out of the network causes significant changes in the system voltage. A weak system will also be affected considerably due to the disturbances caused by the addition of new elements such as loads or generators. If the SCR value of a bus is less than 5, it is usually not recommended to connect RE to that system. A high short-circuit power capability at the connection buses, about 20 times more than the wind or solar PV capacity will be needed to ensure reliable system operation. This will restrict the possible integration of the RE to the distribution system. If the RE based generator is far away from the network bus, long feeders will be required to connect them, and this will reduce the fault level due to increased line impedance. The impact of a renewable energy generator on the network is therefore very dependent on the fault level at the point of connection as well as on the size of the proposed generator. Accordingly, the point of common coupling for connecting a distributed generation must be carefully chosen. It is obvious from that for grid integration of large amounts of wind or PV, the PCC voltage level has to be as high as possible to limit voltage variations. The suitable voltage level at which a renewable based generator is to be connected with the power grid dependents on its capacity as well.

Table II gives the maximum capacity of renewable based distributed generators that can be connected at different low voltage networks. Connecting at a higher voltage is usually more expensive because of the increased costs of transformers and switchgear and most likely because of the longer line required to make connection with the existing network.

Table II: Limit of Renewable Generation on Distribution Grid

Network Voltage	Max. Limit of Ren. Generation
400V Feeder	50kVA
400 V Busbar	200-250 kVA
11 kV feeder	2-3 MVA
11kV Busbar	8 MVA
63kV to 90kV feeders	10-40 MVA

3.2 Network Voltage Variations

In a standard distribution system, the bus power is set so that during load variability, the electrical power along the feeder will usually be stored within an acceptable range around the limited value. The presence of units that produce a distribution bus will switch on electricity to all feeders connected to that bus. In idle feeders, the voltage can exceed both the upper and lower limits, and in the apportioned device (DR), the electrical power will exceed the upper limit. The amount of power variability depends on the load and local generation. Increased power distribution (ΔV) caused by a generator that supplies active energy (P) and active energy (Q) is provided by

$$\square V = \pm$$

where, R = line resistance, X = line inductive reactance, and V = nominal voltage of the circuit.

The increase in feeder power is a function of the X / R ratio of the line. For HV transmission lines, the X / R ratio is high (e.g. X >> R) due to geometry and low conductor resistance. Distribution servers are characterized by a low X / R value (e.g.R compared to X). For example, in the 400 kV line, X / R = 16, and the 11 kV line, X / R = 1.5. The voltage profile of the distribution system with and without DG is shown in Fig. 7

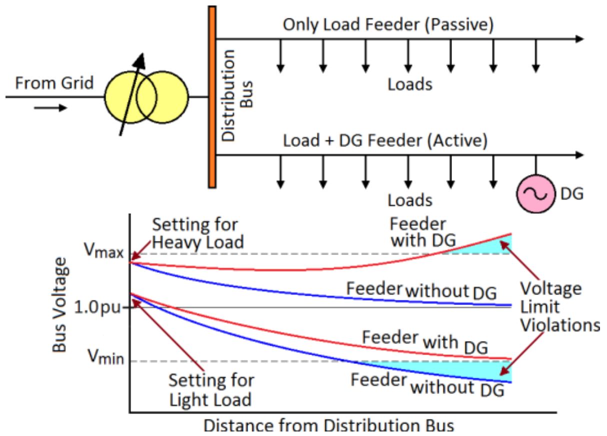

Figure 7: Voltage profiles along the distribution feeder

Another issue affecting the operation of an unequal power distribution system. At the distribution level, loads and renewable generators can be in three phases or single phase. Connecting a single phase 5 source, such as a small PV source, will increase system inequality. Similarly, unbalanced distribution systems can cause problems with the three RE components connected to it, as unbalanced currents from the generators can cause constant heat and shutdown.

3.3 Power Quality

Electrical quality can be defined as a set of boundary values, such as continuous service, voltage and voltage variations, passing cables and currents, and harmonic content. A power quality problem is defined as any deviation in size, frequency, or shape of the current and current power supply system leading to the failure or malfunction of customer equipment. The increased allocation of WTGs and PV systems to the power grid leads to more energy quality issues. In the case of PV systems, PQ problems arise due to variations in solar radiation, cloud shadow, power of electronic modules such as inverters and filters due to inaccurate performance. In the case of wind turbines, PQ problems arise due to variations in wind speed, tower shadow, yaw error due to inconsistencies between wind direction and turbine orientation and power of electronic devices. Similarly, energy-related factors can be divided into two main groups: a) those caused by declining energy sources and b) the connection of power to the energy system.

PQ issues due to fluctuating resources are

- Over voltages during feed-in
- Long and short time voltage fluctuations
- Unbalance
- Frequency deviations

PQ issues due to the power electronics interface

- Harmonic injection
- Resonance phenomena
- Inrush currents
- Decreased damping of the grid due to nonlinearities

Problems related to power variables include over-voltage, under-voltage, sags, swells, spikes, surges, flicker, unbalance and voltage.

Voltage sag is to reduce the magnitude of the power (10-90%) followed by the restoration of electricity after a short time. This is due to temporary faults in the region or to the onset of large motors. In addition to estimates of very short length and maximum magnitude, they are called voltage spikes (length: μs). Flicker is a temporary or aperiodic variation in the voltage system that can lead to significant changes in light output. Slow dynamic buttons, at a frequency of 0.5-30 Hz, are visible to humans. In the case of PV systems; in that case, the difference in strength is due to the passing of clouds. In the case of WTGs, the flicker is caused by fluctuations in output capacity due to variations in wind speed, wind shear, and tower shadow effects. WTGs with variable speed have shown better performance related to flicker emissions compared to faster WTGs. Harmonics is a sinusoidal force and frequency waves with a combined frequency of the basic frequency. Harmonics is associated with distortion of the basic sine wave and is produced by the incompatibility of electrical components. The effects of Harmonics are rising currents, energy loss and overheating of the devices leading to premature aging of the devices. Reduction of service life of equipment was reported as 32.5% of single phase equipment, 18% of third phase equipment and 5% of transformers. Harmonics can also lead to disruptions in display and lighting, circuit breakdown, mechanical malfunction etc. PQ issues can be reduced in two ways, either on the customer side or on the resource side. The first method, known as load loading, ensures that the connected equipment is not too sensitive to power supply interference, which allows for operation even under electrical power distortion. The second solution is to install line correction systems that suppress or close the PQ-related disruption. Power storage systems (flywheels, super-capacitors etc.), as well as other devices such as voltage transformers, harmonic filters, sound filters, surge suppressors, isolation transformers etc. They are used to reduce certain PQ problems. Recently, many FACTS (Flexible AC Transmission System) devices such as DVR (Dynamic Voltage Restorer), STATCOM (Static

Compensator), DSTATCOM (Distribution-STATCOM), SSSC (Static Series Synchronous Compensator), SVC (Static Var Compensator)), TCSC (Thyristor Controlled Series Compensator), and UPFC (Unified Power Flow Controller) etc. are also used to reduce PQ.

3.4 Voltage Ride-Through (VRT) Capability

DFIG-based turbines are the main technology used in wind production systems. These WTGs are very sensitive to changes in electrical energy on a connected grid. In times of abnormal electrical activity, continuous operation of DFIGs can result in over-destruction of currents in the rotor winding or at large voltages in the dc-link capacitor. Similar situations arise with converters used in PV systems. In the early stages of a renewable grid integration, for safety reasons; in times of abnormal electrical power, converter-based generators are used to disconnect from the faulty system. However, with the increase in renewable energy, such practices are not widely permitted and therefore, wind generators and PVs must continue to operate during grid events. In order to enable air and PV systems to stay connected between unfamiliar energy conditions, they need to be ridden with power. VRT power helps to generate active power in an effort to strengthen the grid. In addition to the VRT capability, DRs must disable power variations of more than ± 10%. Errors in the power grid lead to power stresses in a large area, during error and during strong post behavior. In a standard system with compatible generators, forcing a field will help keep the unit in sync. Since this feature is not available on distributed generators, the terminal power will be severely depleted during errors. If a single unit travels due to low voltage, this will cause stumbling in other parts, which may lead to a grid event that emphasizes the grid continuously. To avoid this, DRs should not be disconnected from the network during low system power levels. Such needs are called Low Voltage Ride Through (LVRT). During the post-error period, a large explosion may occur over a wide area due to a strong recurrence. These power variations at the transmission level are often spread across distribution systems to which DR is connected. Excess power can rise due to load spills or uneven errors. The magnitude and duration of the high-energy gas will depend on the nature of the error. To support this program in the short term of such restrictions, DRs should not be isolated. This requirement is called High Voltage Ride Through (HVRT). In many countries, the power of LVRT is now forced into the integration of the DR grid. Fig 8 shows the requirements for LVRT and HVRT according to IEEE Std. 1547, and the requirement of LVRT specified by a few rich countries that can be revitalized, including India. According to IEEE Std. 1547, wind-connected grid and PV plants are expected to stay online and ride zero-voltage faults, e.g. 100% drop in voltage, up to 150 ms. Non-travel area is set for power recovery up to 2 s. The need for HVRT is 140% for 150 ms and 120% for 2 s. In India, wind turbines connected to 66 kV and above buses, 85% transmission with up to 300 ms and renewable power can be up to 3 s. These generators are required to increase the active power until the time when the electric power starts to recover or 300 ms, which is always a minimum. There are two ways to improve the LVRT power of generators based on wind turbines in the event of a fault: a) by reducing the input to the wind turbine and b) by increasing the WTG output. Turbine input can be reduced by pitch blade control. Generator output can be increased using modified capacitors, SVC, STATCOM, Unified Power Quality Conditioner (UPQC), DVR, and braking resistor etc.

3.5 Reactive Power Compensation Capability

Vertical power imbalance (VAR) is one of the major causes of power outages in the power network, leading to power outages on buses and lines. Induction generators used in wind turbines of type A (limited speed) and Type-B (limited speed) require active power support. Without load, these WTGs use an active power of about 35-40% of the calculated power, and when complete, the VAR requirement increases to about 60%. Capacitor banks are often used to pay for VAR requirements. That is, these types of WTGs do not play a role in controlling the power of the system.

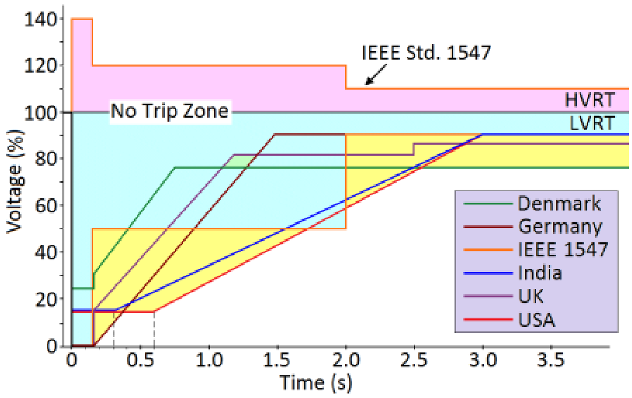

Figure 8(a): Voltage ride through requirements.

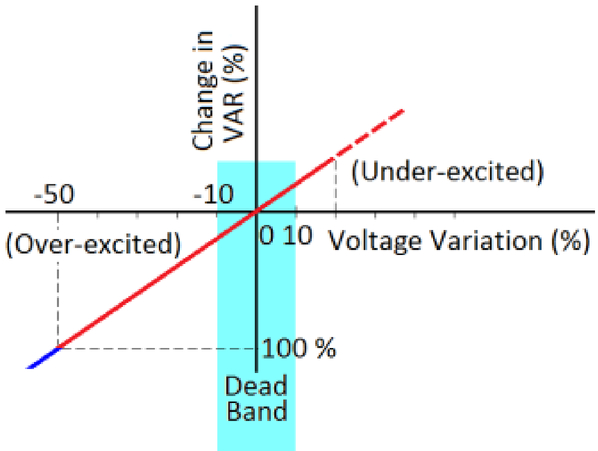

Figure 8(b): VAR capability of WTGs

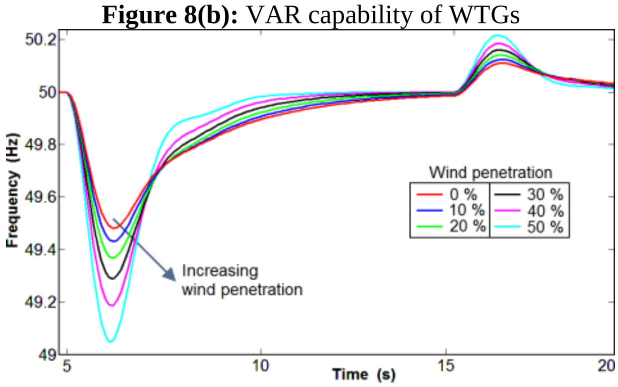

Figure 8(c): Freq. profile in absence of droop & inertia

In fast-moving flexible WTGs and solar PV systems that use autonomous power, VAR can be controlled to reduce losses and increase energy stability. These systems can have a unified power factor and can be used for power control. In large power systems, an energy efficient compensation device, such as SVC or STATCOM can be used to improve power control capacity. For example, the German app requires an active current injection according to the droop line shown in Fig. 8b, a minimum of 2% of the positive current sequence in all percentages of energy consumption is less than 100%. This means that for errors with strong interference of 50% or less, the current active component goes to 100% or more, up to 1.1-1.2 pu, depending on the current converter rate

3.6 Frequency Regulation Capability

Conventional standard generators have two very important features that are very important in controlling the frequency of the grid. These are: a) system inertia and b) velocity

Inertia is the area of the body that resists any changes in its motion. The inertia of the energy system is equal to the number of rotations in the system. Determines the frequency conversion rate (ROCOF) following the upload event. The greater the inertia of the system, the less is the ROCOF following the power imbalance. The first action of the turbine controller shortly after the loading event, known as the basic control, establishes an effective power balance between production and demand through a limited control action, known as a droop, binding to a frequency deviation due to load modification. The droop parameter in the control control loop allows multiple units to share standard loads.

To make power conversion efficiency more efficient, many wind farms use WTG flexible speed technology. To prevent the production of wind speed variations such as frequency variations in the grid, variable WTGs use the power to convert ac-dc-ac power through the grid connection. The dc bus in the middle of the converter causes a decrease in electrical power between the machine and the grid. Thanks to this combination of ac-dc-ac, wind turbines, although very complex, seem very simple in the system. Therefore, the increasing presence of WEC systems in the power system will reduce the effects of standard compatible generators that provide the bulk of the active power required for the grid. The whole system will then behave like a simple system. The light system will deal with major changes in frequency and even minor variations in feed and demand.

Increased input of wind power and solar energy into the power grid increases the equal parameter of the system. An increase in droop value translates into a weak system, less responsive to loading changes and as a result, the most common visits are triggered after every system event. As the droop parameter is integrated into the prime speed control loop of the prime-mover controller, increasing the droop value will reduce the overall control power of the productive unit. Figure 5c represents the frequency profile of the system after a small increase in load, with no inertia and decrease.

Another requirement of a productive unit to participate in regulatory frequency is the availability of sufficient production limits to meet the sudden increase in demand for demand or the stumbling blocks of other manufacturers. Traditionally, fast-moving WTGs and solar PV systems are constantly operating at a high-energy power tracking (MPPT) curve to obtain high power from that source. This leaves no capacity to conserve energy with frequency control requirements. Therefore, these generators provide very little or no support for the frequency regulation of the system.

3.7 Protection Issues

The major security issues associated with the grid connection of distributed resources are: a) short-circuit circuit conversion, b) power flow flow, c) continuous error, d) protection blinding and e) islands.

1) Change in Short Circuit levels

A straight grid connected to a synchronization machine based on DRs that increases network error rates. Induction generators only offer limited error streams, not in a sustainable manner. As seen earlier, the high error level indicates a strong grid, where the negative effects of connecting a new DG to PCC power will not be so bad. However, an increase in network error rate due to DG additions represents another problem with system security. The current short circuit level in the network is the main parameter used to determine the ratio of CTs, CBs etc., and the correlation between overpowering. The shorter circuit level is characterized by an equal system impedance in the error area. With the connection of generators, the impedance of the equivalent network can be reduced, which has led to an increase in error rate. The current error under this condition may exceed the ability to violate existing CBs. High incidence rates can also lead to CT complement. In addition, altered error rates can interfere with the interaction between overload transfers leading to unsatisfactory performance of the defense systems. The contribution of the DR error rate can be reduced by bringing the impedance between the generator and the network, by a transformer or by a reactor. However, this will increase the loss and lead to wider power dissipation in the generator.

Distribution networks are usually spreadable and generally secure systems using integrated time protection schemes. Most distribution system protection finds an unusual situation by distinguishing the current error from the normal load load.

To illustrate, consider the distribution system shown in Fig. 6. In the absence of DG, the currents detected by feeder breaker CB-1 and Recloser RC are approximately equal to the current IF error (i.e. IS ≈ IRC ≈ IF). However, when the DG is connected, IRC = IS + IDG, and IRC> IS. This is a common occurrence in radial passive networks. This does not cause a problem if the interference capacity of the reclosed is sufficient to handle the increase in increased error. However, it is possible that the connection between the reclose and any of the lower fuses (for example between RC and Fuse-1) is lost. Because both the recloser and the fuse operate faster at higher error rates, the required gears between the speed of the reclose curve and the fuse curve can be reduced to the point of contact loss.

2) Lack of Sustained Fault Current

In order for the transmission to be reliably detected and to separate the fault currents from the normal load noises, the defects must cause a large and continuous increase in the measured currents. If the current fault offering from the DG is limited, it becomes difficult to overprotect based on defect detection. Renewable energy generation usually uses induction generators, small compatible generators or power converters. The input generators are unable to supply continuous error currents to three-phase errors and make a limited error offering in asymmetrical errors. Small compatible generators often do not have the ability to deliver continuous error currents that are much larger than currently rated. Power semiconductor devices cannot withstand significant explosions of solid frequencies so power transformers are designed to limit the internal output current. The lack of continuous errors jeopardizes the ability to transfer back to find errors.

3) Blinding of Protection

Prior to distributed production, the grid contribution to current total errors will decrease. Due to these reductions, it is possible for the short circuit to remain unavailable because the grid contribution in the short-term cycle does not now reach the feeder transfer take-off. The operation of the override transmission, the transmission transmission and the discharge depend on the detection of abnormal currents. Therefore, protection based on these devices may not work properly due to reduced grid contribution.

4) Islanding

Islanding is a state in which part of a network is disconnected from the main grid and acts as an independent system supplied with one or more electricity. The island results in unusual variations in frequency and power in a single network. Opening an auto recloser during a fault can lead to the creation of two independent systems operating on two different frequencies. Postponing auto recloser while two systems are out of phase can bring catastrophic results. In addition, the operation of the islands can create an unused system depending on the transformer connection. An unknown island will be a danger to maintenance workers. The island is considered an unsafe situation and therefore, the immediate termination of DGs from the main grid is recommended in the event of an island construction.

4. Possible Solutions to Address Renewable Integration Challenges

Several solutions are suggested in the literature to address the challenges associated with diversity and the uncertainty of RE power generation. The main consideration in choosing a particular method is the high cost of technology and network features. Grid infrastructure, operating systems, production type, and control features all contribute to the most economical and effective solutions. Often, systems need more flexibility in order to accommodate more renewable variations. Flexibility can be achieved with better forecasting, operating systems, energy conservation, demand side flexibility, flexible generators, and other methods

1) Predicting wind and solar sources: Sun and wind forecasts can help reduce the uncertainty associated with these generations. It can help grid operators to perform well or make a de-commitment to embracing changes in PV wind and air production, without helping to reduce the number of operating depots. There are different types of predictions such as short-term and long-term forecasts. The short-term forecast, usually in hours, is more complex than the long-term forecast. Weather errors typically range from 3 to 6% of the estimated dose one hour earlier and 6 to 8% over the next day.
2) Operating Practices: Fast Delivery and Large Remote Control Areas: Fast deployment helps manage RE variability as it reduces the need to manage resources, improves efficiency, and provides access to a wider set of resources to scale the system. With faster shipping, loading and production rates can be closely matched, reducing the need for more expensive control resources.
3) Warehouse management: Warehouse modification practices can be used to help deal with variations in wind and solar power. This includes a). imposing restrictions on wind energy and PV to reduce the need for reservoirs and b). by enabling flexible renewable energy to provide repositories or other auxiliary services such as regulation, inertia etc.
4) Connecting widely distributed resources: The effects of RE power flow can be mitigated by connecting a large number of small resources distributed over a large area instead of a large unit focused on one place. The total output fluctuations will be minimal as the location variation affects only the smaller units, not the total output power.
5) Energy Storage: with increased renewable energy levels, energy conservation is a common solution to reduce generation. One of the most expensive end-to-end systems is the "over-construction" (200-300%) and reduction.
6) Wind-PV hybrid systems: Since the effects of wind and solar PV are interrelated, the hybrid arrangement of these devices will improve the decline of public power to some extent.
7) Demand Response: Flexibility on the demand side is a great way to minimize the effects of a built-in approach quickly. Demand response can be used to provide repositories and support services as well as high-density deployments. The use of a response to demand to balance the system during rare events where there is very little or more use of the renewable generation can lead to cost savings compared to continuing to maintain other warehouses.

5. Conclusion

In addition to the above the increase in environmental awareness and energy safety has pushed renewable energy systems at the top of the power generation system. Among the various renewable energy resources, PV and solar systems show a significant growth rate over the years and are capable of grid integration. Due to the small amount of wind energy and sunlight compared to fossil fuels, the production of energy from these sources usually takes place in a distributed manner. The integration of RE-distributed distributed generation of the power system can be done at the transmission level or distribution level, depending on the performance scale. However, due to the proximity of the distribution system to remote areas where most RE-based generators are installed, they tend to be connected to a standard distribution grid. Due to the flexibility and intervals of the renewable device, the production technology used in these components differs from standard units. The frequency of power generated by these units will not exceed the normal operating frequency and therefore, a large DG technology group uses the power to convert electronic material to a grid connection. The decline in mechanical power from the system system to the power of electronic devices introduces a number of technical issues. This paper has reviewed some of the technical challenges that need to be addressed in the effective grid integration of usable generators based on renewable energy. Of particular concern in coordinating renewable energy production at the distribution level is related to energy control, energy quality and protection.

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