

GRID INTEGRATION PROBLEMS AND THEIR SOLUTION

Abstract

Due to its many advantages over conventional energy systems, renewable energy sources are increasingly being used throughout the world. Additionally, recent technological developments in power electronic converters and electronic components have significantly lowered the cost of “renewable energy sources” (REGs), such as solar, wind, and many other sources. Most wealthy nations have set energy goals for the production of renewable energy. By 2022, India hopes to generate 175 GW of electricity from “renewable sources”. Early on in the introduction of RE integration with the grid was not a problem, and connecting or disconnecting RE from the grid was simple. However, grid integration is a problem as it would influence grid stability as RE penetration rises. In this article, the issue with integrating RE into the grid is discussed, along with possible solutions.

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I. INTRODUCTION

The usage of renewable energy sources is expanding quickly globally as a result of the exhaustion of fossil fuels and the resulting environmental issues. “The cost of power electronic-based renewable energy sources like solar and wind energy systems has decreased” as a result of recent advancements in power electronic devices. This has also prompted their widespread use all across the world. Global electricity generation from renewable sources has expanded by more than 500 percent in the previous 50 years from 1965. As of January 31 2020, India's installed capacity was 367,281 MW [1]. About 23.4 percent of the total generation, or 86,321 MW, comes from renewable sources [2]. India will reach its ambitious 175GW clean energy objective by 2022, of which 100GW from solar and 60GW from wind are planned, as soon as it surpasses the 100GW renewable energy capability threshold in the year 2020.

FUEL	MW	% OF TOTAL
Total Thermal	2,30,701	62.8%
Coal	1,98,495	54.2%
Lignite	6,760	1.7%
Gas	24,937	6.9%
Diesel	510	0.1%
Hydro (Renewable)	45,399	12.4%
Nuclear	6,780	1.9%
RES* (MNRE)	86,321	23.4%
Total	368,690	

Table 1: Total Installed Capacity As On 31 Jan 2020

Renewable energy integration into the grid has both positive and negative effects. The benefits include less traffic jams, dependable power, energy safety, a decrease in greenhouse gasses, and a halt to global warming. However, the problems brought on by grid integration are highly difficult and require attention. After integration, power variations cause unacceptable voltage instabilities at some nodes in the electric network, excessive power swings along feeders, and unstable functioning of the electric network. Renewable energy sources cannot be taken into account during the generation scheduling process due to their unpredictable swings in power output.

Voltage and frequency are the two factors that guarantee the grid's steady operation. More smoothly fluctuating voltage and frequency changes follow system events when there are more generators involved in frequency and voltage regulation. “When frequency or voltage deviates from their respective nominal values, RE sources don't increase or decrease their MW or MVAR outputs, and as a result, they don't account for frequency and voltage fluctuations”. This deficiency of RE will impede the adoption of these technologies into the grid because frequency and voltage consistency is essential for preserving system stability. “It is common practise to disconnect RE during emergencies and reconnect them once the system is back to normal in cases when RE penetration into the grid is low. However, with the growing percentage of RE”, this method is no longer acceptable because cutting them off during emergencies would make the situation worse because more power would be lost.

II. GRID INTEGRATION ISSUES

Grid integration can be carried out either at the distribution level or at the transmission level, depending on the magnitude of the renewable energy power source. However, because renewable energy sources are intermittent, integrating them into the grid is a difficult undertaking. The technical difficulties with their grid integration are as follows: Voltage fluctuations, voltage level, and the Point of Common Coupling, “Power quality”, “voltage ride-through (VRT) capabilities”, “reactive power capabilities”, and Protection issues.

- 1. Voltage fluctuations:** In a traditional distribution system, the bus voltage is regulated to maintain an acceptable range around the nominal value even when there are changes in the load along the feeder. However, the voltage of each feeder connected to a distribution bus will fluctuate if there are generating units there. The load and nearby generation affect how much voltage varies. Another problem that impacts the distribution system is unbalanced voltage. At the distribution level, both the loads and the renewable energy generators can operate in single or three phases. The system will become more unbalanced if single-phase sources, like tiny PV, are interconnected. Similar to this, a distribution system that is essentially unbalanced can be problematic for three phases RE linked to it since the consequent imbalanced currents in generators can lead to overheating and frequent shutdowns.
- 2. The Point of Common Coupling (PCC):** The PCC, is where several generators and loads are connected to the grid. “Generators will now be the main source of disruptions. PCC should be available to both utility and customer, under IEEE Std 519 [3]. The fact that it shouldn't degrade the quality of the power should be a prerequisite for connecting the generator to the grid. As a result, both the generator's source and the fault level at the connection point have a significant impact on how REG affects the network”.
- 3. Power quality:** Any fluctuation in the magnitude, frequency, or waveform shape of the voltage and current that causes the failure or malfunction of client equipment is referred to as a power quality problem [4]. There are numerous PQ problems as a result of the rising use of WTGs and PV systems in the power grid. When it comes to PV systems, the power quality issue is brought on by solar radiation variance, cloud shadow, power electronics devices like inverters, and filters because of their nonlinear manner of operation. When it comes to wind turbines, PQ issues might occur because of changes in wind speed, tower shadow, yaw error caused by an incorrect alignment of the blades with the wind, power electronic components, etc. As a result, power quality problems can be roughly divided into two groups: those produced by the power electronic interface and those caused by the fluctuating nature of energy sources. Issues with RES Power Quality include over-voltages, long- and short-term voltage fluctuations, imbalance, frequency aberrations, and others because of the fluctuating nature of RES power. Issues with power quality caused by the power-electronic interface include harmonic injection, resonance phenomena, inrush currents, and a reduction in grid damping as a result of non-linearities.
- 4. Protection issues:** Reverse power flow, a shift in short circuit level, a lack of continuous fault current, blinding of protection, and islanding are the main protection difficulties associated with the grid connection of RES. The level of network faulting rises with RES

integration. Induction generators offer a finite amount of fault current. Strong grid with a high fault level means that connecting a DG may not have detrimental impacts on PCC voltage. However, the rise in network failure level brought on by the addition of DG poses a different problem in terms of system defence. Furthermore, the grid's contribution to the failure will decrease in the presence of distributed generation. Because the grid's contribution to the short circuit current never reaches the pickup current of the feeder relay, there is a potential that a short circuit will go undetected in this situation. The direction of anomalous currents affects how overcurrent relays, directional relays, and reclosers operate. As a result of the grid's diminished contribution, protection provided by these devices may malfunction. When an island forms, DGs must be immediately cut off from the main grid because islanding causes ridiculous voltage and frequency changes in the isolated network.

III. SOLUTION FOR INTEGRATION PROBLEM

In the literature, a variety of potential solutions are put out to alleviate the problems caused by the fluctuation and unpredictability of renewable generation. In general, systems require more flexibility to accommodate the increased fluctuation of renewable energy sources. Better forecasting, operational procedures, energy storage, flexible generation, demand side flexibility, and other techniques can all help to increase flexibility [5].

1. The uncertainties related to these generations can be reduced with the aid of solar and wind forecasting. Along with assisting in the reduction of operational reserves, it can assist grid operators in more effectively committing or decommitting units to account for fluctuations in wind and PV power.
2. Fast dispatch allows load and generation levels to be more closely matched, which reduces the need for more expensive regulating reserves. It also allows for bigger balancing zones.
3. By interconnecting multiple small distributed resources dispersed across a wide geographic area rather than a single large unit, the effects of intermittent RE power can be reduced. The total output will fluctuate very little since local differences only have a modest impact on individual small units, not the entire output power.
4. A hybrid configuration of these two resources will help reduce total power fluctuation to some extent because Wind and PV outputs are complementary types.
5. The VAR can be managed to reduce losses and improve voltage stability in solar PV systems employing self-commutated PE devices and variable speed WTGs. Both voltage control and a power factor of unity are possible with these systems. A central reactive power compensation device, such as SVC or STATCOM, may be utilised for large capacity systems to increase the capability of regulating reactive power.

IV. CONCLUSION

The growth in generation from renewable sources is a result of the depletion of fossil fuels and growing environmental concern. The focus worldwide is on expanding the production of electricity from renewable sources. The price of RE has decreased as a result of technological advancements in power electronic devices. Power generation from wind and sunlight typically occurs in a distributed fashion because of their lower energy density when compared to fossil fuels. Either the transmission level or the distribution level is where RE-

based distributed generation is integrated. Renewable energy sources provide a number of difficulties for grid operators because of their variable and intermittent nature. Before integrating them into the grid, there are a few technical issues that need to be resolved, and this article evaluates those issues and makes recommendations. Voltage control, power quality, and protection are the main issues that need to be addressed before connecting them at the distribution level.

REFERENCES

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