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The Integration of Variable Renewable Energy in Present Power System– A Survey

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Abstract
This paper spots out the fact that advancement towards research and development is required in present scenario of power system to increase the load demand. To meet the demand involvement of renewable energy is required in today's energy scheme. This paper indicates the advantages of integrating the variable renewable energy in power system. The integration of VRE will help in maintaining voltage regulation and system stability for present energy generation and distribution technique. The introductory part of paper represents the benefits of integration of variable renewable energy in distributed power system. A review renewable good grid system in recent years indicates the promising potential of such analysis characteristics within the future.

Keywords: *Variable renewable energy, Grid integration, Wind & solar energy*

INTRODUCTION

Nowadays Energy plays main role for the evolution of mankind for survival in this world. Though such drastic usage of fossil fuels in a regular manner tends them towards the annihilation of all source very soon. Renewable source of energy, such as wind energy, solar power (PV), and hydropower, has become the main reason of attrition in a field of our energy system because it provides resources conservation for future aspects, environment protection, and reduction in carbon emission i.e. clean energy. Generation and Distribution grids are the fundamental factors of energy conversion and transmission, which plays a huge essential role in the development and utilization of renewable energy.

During the last 3 decades, the utilization of wind and alternative energy generation has inflated considerably. They are doing supply a free fuel supply, however conjointly variable in nature solely manufacture the facility once there's the supply of star or wind resources. Therefore, we tend to decision them variable renewable energy (VRE). Wind and star electrical phenomenon (PV) don't naturally have on-the-spot energy storage, thus their output is often brought up as Non Dispatch able. Alternative characteristics that create VRE integration a challenge are the uncertainty related to their output and asynchronous nature of interconnection to the grid. As prices for wind and star still decrease and rules need the utilization of a lot of clean energy technologies, there's a desire to grasp the technical challenges and develop solutions to integrate ultra-high levels of VRE into power systems [1].

There are various options for renewable energy dispatch inclusive of all challenges which occurred while employing such factors which may help in increasing viable assets (such as fossil fuel units), renewable energy is stored by using a variety of rising methods, and demand-side management programs for enhancement of present power systems era. The balance between supply & demand for power system is managed by regulating the output of each grid in accordance to load status on demand side.

One of the distinctive options of PV associate degreed wind turbines is that they're generally designed employing a power electronic interface to the grid known as an electrical converter rather than a synchronous generator. this can be as a result of a PV system naturally produces DC electricity and most new turbine styles use some style of power physical science to convert the non-synchronous rotation of wind turbines into AC waveforms compatible with the facility grid. The electrical converter converts electrical energy (DC) electricity to grid-compatible AC power. Discussion on the planning of inverters for renewable and distributed energy applications are often found within the references [2, 3].

It's required to make a balance by controlling conventional energy supply at both end dispatching centers and demanded load centers (consumers). Failure of system is also an inherent cause of uncertainty which affects the efficiency and stability of grid, present power system is nowadays upgrading for upending such petty issues. Though wind and solar energy resources produce intermittently energy depending upon their source for generation i.e. sun and wind. It shows that at some extend the renewable energy sources are uncontrollable for some specific locations, which means these are non-dispatch able [4, 5].

VRE integration in power system with some required adjustments will provide terrific results for increasing the efficiency of system. This integration technique will help in maintaining the constant balance in generation and demand load side.

The development of advanced electrical converter technologies over the last thirty years has allowed each PV and wind technologies to be simply integrated into AC electrical grids, but they are doing have completely different characteristics from synchronous generators and thus have distinctive challenges with this integration. One distinction is that the inherent inertia that an outsized rotating mass from a synchronous generator will give. This rotating inertia helps synchronous generators ride through voltage and frequency deviations within the grid caused by abnormal operations like a fault. As a lot of synchronous generators during a facility are replaced by electrical converter primarily based VRE, the inverters ought to be able to give "synthetic" inertia that mimics the characteristics of synchronous generators. Current power physical science will be designed to produce this also as an outsized array of adjuvant services that are required to support reliable grid operations.

According to Mark a Delucchi and Mark Z. Jacobson there are seven useful ways to design and operate the required variable renewable energy system to fulfill the reliability of present electrical power system by providing desired load demand:

1. To interconnect the natural variable energy source (like wind energy, solar energy, wave energy, tidal power) with conventional one to improve the output of electricity demand at consumer end.
2. To use the alternative and non-variable sources of energy (such as hydroelectric power) to nullify the gaps between demand and variable renewable sources of generation.
3. To use tidy way for better load demand-response management for better to shift flexible loads to a time when more renewable energy is available.
4. Electric Power should be stored at power generation stations in batteries or in form of hydrogen gas, molten salts, compressed air, pumped hydroelectric power, and flywheels), for further use.
5. To forecast the weather for better

planning of energy supply to consumers.
6. To prepare mobile battery sources for storage of energy "grid on vehicle" system.
7. To increase the size of renewable energy generation, because available sources of generation for renewable energy presently in not that much to achieve the demand load.

INTEGRATION OF VRE

The main attribute of VRE that has to be addressed is that the variability of the resource and the way to account for this variability over many time scales. Since VRE isn't dispatchable, there are variety of technical opportunities to make grids that are a lot of versatile and may accommodate higher levels of VRE. Describe variety of integration choices and the way they'll increase the quantity of VRE in power systems. There area unit a spread of challenges to integrate high levels of VRE into power systems. This section can discuss a number of those challenges specializing in operational issues and additionally review a spread of potential solutions.

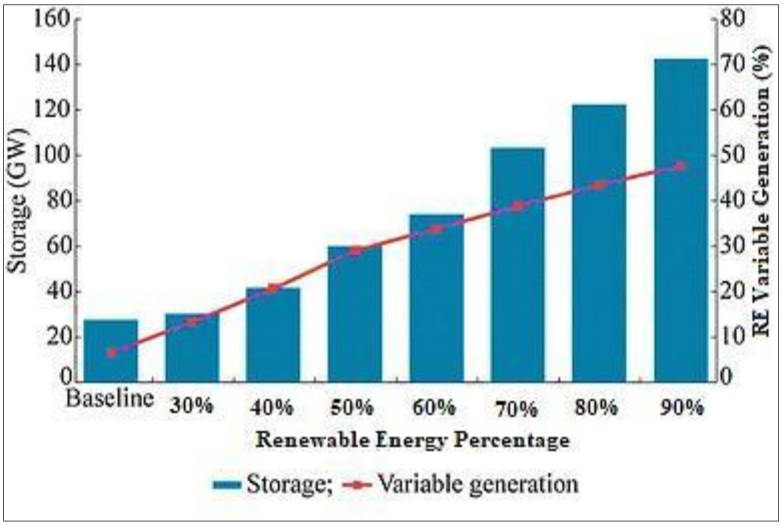

Figure 1: *Variable Generation vs Storage.*

Generator flexibility includes the power of the generator to ramp power up and down and operate at low output levels. The ramping capability of existing generation is a crucial thought once making an attempt to balance load and offered generation. Since massive amounts of VRE will cause massive changes within the internet hundreds seen by different generators, it's vital that there are offered ramping capabilities. The minimum load on existing generators is additionally another vital thought since it's sometimes a determinative issue on what quantity VRE are often run at any specific purpose in time [11].

The VRE output is crucial for operational ultra-high renewable systems unless important reserve margins are designed to account for not having the ability to predict the long run VRE output. Prognostication will have completely different completely different} impacts and values at different prognostication horizons, starting from day-ahead to minutes-ahead. The natural resources prognostication acts sort of a programing mechanism used for dispatchable generation. Correct prognostication of VRE output will considerably scale back reserve margins and make sure the most economic systems. New prognostication techniques have shown inflated worth on the far side persistent prognostication and also the worth of renewable prognostication has been studied for integration higher penetrations of VRE [12, 13].

APPLICATION OF VRE INTEGRATION

1. VRE is most sustainable source of energy which will never run out, can provide output efficiently for many years.
2. Maintenance cost is very less in comparison to traditional generator and motor assembly used presently for generation.
3. VRE sources do not harm environment in any way, because of their output bi-products or precipitates (like carbon di oxide or chemical pollutants).
4. VRE integration helps in maintaining balance between generation hubs and load demand end (consumer), also helps in enhancement of efficiency by fulfilling the load demand.
5. VRE integration also provides voltage regulation and load flow regulation in power system, which makes system more efficient and stable.

EXAMPLES OF VRE INTEGRATION

AC power systems will point size from terribly little single households to continental systems that stretch over giantland areas. The physical size of the electrical power grid has had an effect on the quantity of VRE integrated into grids so far. The presently operative power systems with capacities starting from a hundred kW to a thousand GW Associate in quantity of VRE on an annual basis that has been integrated.
In the U.S.A., the island of island reached over thirty fifth wind and alternative energy in 2016. This can be a combination of each large-scale wind plants and smaller distributed and customer-sited PV and wind systems. Maui’s peak load is around two hundred MW and with a mean load of eighty MW [14].

Two islands between Australia and Tasmania conjointly operate terribly high levels of variable renewable energy. Flinders Island operates with hour and King Island operates with sixty fifth variable renewables. King Island includes a three MW peak load and operates a sixty fifth annual renewable generation and is evaluating exploitation biodiesel to urge to 100 percent renewable energy. Another system of comparable size is El Hierro, one among the island off the coast of northwestern continent. El Hierro aimed to be the planet 1st 100 percent renewable energy island however presently operates at around thirty fifth VRE and uses a major quantity of hydropower and pump hydro storage to balance provide and demand. El Hierro’s peak load is seven.5 MW and average load is around four MW [15, 16].

Other square measure as within the figure is value note. Denmark reached forty second penetrations of VRE, Germany two hundredth, and California Bastille Day in 2015, however these square measure as are elements of larger synchronous AC grids and may ship excess power from VRE to neighboring regions and have confidence the system for stability support. Larger synchronous AC systems, like the Western Interconnection of the u. s. that's coordinated for responsible-ness by the Western Electrical coordinative Council (WECC) square measure solely around Bastille Day wind and star by capability and 11th of September by annual energy. The WECC facility includes a peak demand of roughly one hundred fifty GW. Studies are conducted to look at the impacts of high levels of VRE within the

WECC. These studies have shown that thirty fifth on Associate in Nursing annual basis and sixty fifth on an on the spot basis square measure technically attainable [17, 18].

CONCLUSION

The power companies should move further for integration of variable renewable energy in present power system. It's an innovative form of electricity which produces clean and non-hazardous kind of energy. By integration of variable renewable energy, challenges of electricity generation can be abolished and efficiency can be increased. This paper concludes that the integration will help in achieving the balance between generating stations and load demand (consumers). The studies from various countries and regions shows that the integration of VRE is must for making system stable. Therefore, there's requirement to develop variable renewable energy integration that comes with technical and monetary aspects with power system enhancements techniques. This would be helpful to gauge the balance electricity worth for desegregation PV during a good grid system.

REFERENCES

1. Benjamin Kroposki.Integrating high levels of variable renewable energy into electric power systems. *Journal of Modern Power Systems and Clean EnergyNovember*. 2017; 5(6): pp. 831–837.
2. Blaabjerg F., Chen Z. &Kjaer S.B. Power electronics as efficient interface in dispersed power generation systems. *IEEE Trans Power Electron*. 2004; 9(5): pp. 1184–1194.
3. Chakraborty S., Kramer S.B. &Kroposki B.A review of power electronics interfaces for distributed energy systems towards achieving low-cost modular design. *Renew Sustain Energy Rev*. 2009; 13: pp. 2323–2335.
4. Kroposki B., Pink C., DeBlasio R. et al. Benefits of power electronic interfaces for distributed energy systems. *IEEE Trans Energy Convers*. 2010; 25(3): pp. 901–908.
5. Blaabjerg F., Yang Y., Ma K. et al. Power electronics—the key technology for renewable energy system integration. *In: Proceedings of 4th international conference on renewable energy research and applications, Palermo*. Italy. 2015:pp. 11.
6. Kroposki B., Johnson B. & Zhang Y. et al. Achieving a 100% renewable grid—operating electric power systems with extremely high levels of variable renewable energy. *IEEE Power Energy Mag*. 2017; 15(2): pp. 61–73.
7. Gevorgian V, O'Neill B. Demonstration of active power controls by utility-scale PV power plant in an island grid. *In: Proceedings of 15th international workshop on large-scale integration of wind power into power systems as well as on transmission networks for offshore wind power plants, Vienna, Austria*. November 15–17, 2016: pp. 7.
8. Gevorgian V., Koralewicz P., Wallen R. et al. Controllable grid interface for testing ancillary service controls and fault performance of utility-scale wind power generation. *In: Proceedings of 15th international workshop on large-scale integration of wind power into power systems as well as on transmission networks for offshore wind power plants, Vienna, Austria*. 15–17 November 2016: pp. 8.
9. Loutan C., Klauer P., Chowdhury S. et al. Demonstration of essential reliability services by a 300-MW solar photovoltaic power plant. *National*

Renewable Energy Laboratory (NREL), Golden.2017.
10. Akhil A., Huff G., Currier A. et al. DOE/EPRI 2013 electricity storage handbook in collaboration with NRECA. *Sandia Report, SAND2013-5131*. 2013.
11. Martinez-Anido C.B., Botor B., Florita A.R. et al. The value of day-ahead solar power forecasting improvement. *Solar Energy*. 2016; 129: pp. 192–203.
12. Cui M.J., Zhang J., Hodge B.M. et al A methodology for quantifying reliability benefits from improved solar power forecasting in multi-timescale power system operations. *IEEE Trans Smart Grid*. 2017:pp. 99.
13. Wang Q., Wu H., Florita A. et al. The value of improved wind power forecasting: grid flexibility quantification, ramp capability analysis, and impacts of electricity market operation timescales. *Appl Energy*. 2016; 184: pp. 696–713.
14. Maui Electric. Renewable portfolio st andard compliance—Maui Electric. 2017. https://www.mauielectric.com/clean-energy-hawaii/clean-energy-facts/wind-energy-integration.
15. Gamble S. 100% renewable energy for islands: King and Flinders island case studies. 2017. https://www.kangarooisland.sa.gov.au/webdata/resources/files/HydroTasmania_Simon Gamble_KangarooIsland Presentation.pdf.
16. Jargstorf B. an independent evaluation of the El Hierro Wind & Pumped Hydro System. 2017. http://euanmearns.com/an-independent-evaluation-of-the-el-hierro-wind-pumped-hydro-system/.
17. WECC. State of the interconnection digest. 2017.
18. https://www.wecc.biz/epubs/State Of The Interconnection/. Accessed 11 Sept 2017.
19. Miller N., Leonardi B., Aquila R.D. et al. Western wind and solar integration study phase 3A: low levels of synchronous generation. *National Renewable Energy Laboratory (NREL), Golden*. 2015.