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Simulation and Optimization of PV-Wind Hybrid system

Nikhil Takkar[1], Shubhankar Srivastava[2], Pawan Kumar[3]
[1,2,3]*Student, Department of EEE, Galgotia College of Engineering & Technology, Delhi, India*

***Abstract*: Among all the renewable resources, wind and solar are the most popular resources due to its ease of availability and its ease conversion into electricity. Each renewable resource uses DC/DC boost converter separately with MPPT control to generate power. To increase the efficiency of photovoltaic (PV) system and wind energy system, the maximum power point tracking (MPPT) technology is employed. Perturb and Observe MPPT technique is used for PV system in which dc voltage is used as perturbation variable. While in wind energy system, perturbation variable as a dc current is used in modified perturb and observe MPPT algorithm. Modified perturb and observe algorithm is stable and tracks fast for sudden wind speed change conditions. Maximum Power Point Tracking (MPPT) technique used with boost converter extracts maximum power from the source when it is available. Simulation of both the renewable energy sources is carried out separately in PSIM 9.0 with different MPPT types of techniques.**

***Keywords*: MPPT, Wind energy conversion system, Solar energy conversion system, Boost Converter, Simulation.**

1. Introduction

The global penetration of renewable energy in power systems is increasing rapidly especially for solar (PV) and wind systems. Today one cannot imagine life without some form of energy such as electricity. The main source of energy has been fossil fuels, which provide 85-90 % of energy. Oil is the most important with35 %, and coal and natural gas are equally represented. Almost13.5 % of energy is derived from nuclear power plants, and only 9.8 % of energy comes from renewable sources. Still, in the world there are many places that have no access to electricity. Industrial plants, lighthouses, mountain lodges, which are far from the power grid should also have their own stand-alone systems. Today, renewable energy is increasingly being considered as one of the key factors in the development of planet Earth. Solar and wind power is naturally intermittent and can create technical challenges to the grid power supply especially when the amount of solar and wind power integration increases or the grid is not strong enough to handle rapid changes in generation levels. In addition, if solar or wind are used to supply power to a stand-alone system, energy storage system becomes essential to guarantee continuous supply of power. The size of the energy storage depends on the intermittency level of the solar or wind. This paper provides a review of challenges and opportunities for hybrid system of solar PV and wind. The paper reviews the main research work related to optimal sizing design, power electronics topologies and control for both grid-connected, stand-alone hybrid solar and wind systems.

2. Hybrid solar PV-wind system

Hybrid solar PV and wind generation system become very attractive solution in particular for stand-alone applications. Combining the two sources of solar and wind can provide better reliability and their hybrid system becomes more economical to run since the weakness of one system can be complemented by the strength of the other one. The integration of hybrid solar and wind power systems into the grid can further help in improving the overall economy and reliability of renewable power generation to supply its load. Similarly, the integration of hybrid solar and wind power in a stand-alone system can reduce the size of energy storage needed to supply continuous power.

3. Battery

The storage system consists of the battery, and the bidirectional DC-DC converter. It has two modes of operation. The SoC of the battery was estimated as follows The equation shows the SoC estimation of the battery where the SoC is the State of Charge, Q is the battery capacity, and Ic is the battery current.

4. Energy management system

The intelligent management system is essential for this decentralized system for the purpose of optimization, and battery management. The intelligent management system also essential for the optimized load flow. The intelligent management system also employs cost prizing of the power, which is consumed by the load. The switching operation of the power system, especially in the converter employed for the particular converting operation, will also be regulated by this intelligent control system. The main objective of the installation of the intelligent management system is to avoid the inadequate operating time, protect the storage system. The intelligent management system provides better solution to the load, which supplies from the fluctuating power supply resources. The algorithm implemented in this intelligent management system has been proven, that it provides the better solution for the battery management and optimization. The intelligent

management system also responsible for balanced power generation. The intelligent management system employed fuzzy control, for the purpose of optimization and distributed energy generation. The DC smart grid system is the nonlinear system requires this centralized control system, which offers the practical way for designing the intelligent management system. This management system requires the difference between the actual load and the total generating power of the system (PV, wind) for the battery management. The SoC of the battery is directly proportional to the life time of the battery. The fuzzy employed in this maintains the SOC of the battery

5. MPPT controller

A. Perturb and observe algorithm for solar energy system.

The Perturb & Observe MPPT (maximum power point tracking) algorithm is shown in Fig. 1. There exists different MPP for different condition of temperature and irradiation which is tracked by MPPT technique and can be delivered to load. The P&O MPPT technique algorithm calculates the power P(t) by measuring the instant voltage V(t) and current I(t) and then compares it with last calculated power P(t-1). The algorithm continuously perturbs the system if the operating point variation is positive; otherwise the direction of perturbation is changed if the operating point variation is positive. The duty cycle of the DC/DC converter is varied till it reaches the maximum power point. With higher step size of perturbation, system may oscillate around MPP which results into wastage of energy.

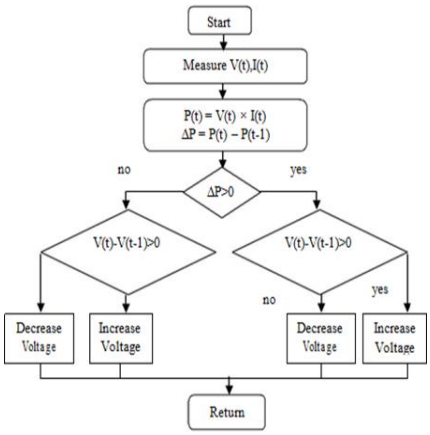

Fig. 1. MPPT controller

Perturb and Observe MPPT technique which is adopted from PSIM software is shown in Fig. Voltage V_cell and current I cell are measured from solar array to calculate power, P_o. Block dv/dt compares, the present value of power with previous value. If increment in power is positive then perturbation variable voltage is incremented by predefined step size. Output voltage of solar panel is compared with this varied voltage value and steady state error obtained is eliminated by PI controller. To avoid over saturation, a limiter should be placed at the output of PI controller which is compared with carrier wave to generate pulse for controlled switch IGBT of DC/DC boost converter.

6. Optimization

A solar PV and wind systems can't provide a continuous supply due to the fact that those systems will generate electricity only during sunny and windy days. therefore, a combination in which these two sources improves overall energy output especially if they are connected to grid. A proper optimization is required to ensure having optimal number and size of PV and WT. The traditional sizing method for hybrid solar PV and wind systems was based on availability of long-term weather data, such as solar radiation and wind speed. Since long-term weather data is not always available, artificial intelligence techniques such as fuzzy logic, genetic algorithms and artificial neural network are used. Furthermore, optimization performance indicators such as Net Present Value, Energy Index Reliability and Energy Expected Not Supplied, Cost of Energy, etc. have been used and reported. Those indicators are used to decide whether to proceed with a particular project or not and how reliable is a project will be.

7. Summary and findings

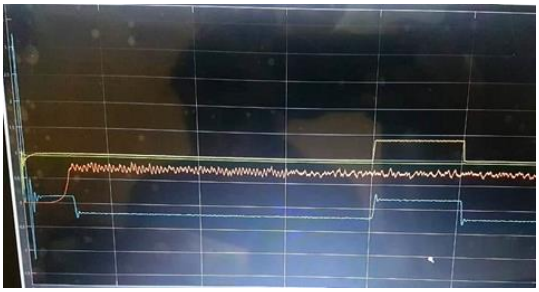

Fig. 2. Output of hybrid system

8. Conclusion

This paper has provided a review of challenges and opportunities on integrating solar PV and wind energy sources for electricity generation. The main challenge for grid-connected system as well as the stand-alone system is the intermittent nature of solar PV and wind sources. By integrating the two resources into an optimum combination, the impact of the variable nature of solar and wind resources can be partially resolved and the overall system becomes more reliable and economical to run. This definitely has bigger impact on the stand-alone generation. Integration of renewable energy generation with battery storage and diesel generator back-up systems is becoming a cost-effective solution for stand-alone type. The wind-battery-diesel hybrid configuration can meet the system load including peak times. Energy management strategies should ensure high system efficiency along with high reliability and least cost. Good planning with accurate forecasting of weather pattern, solar radiation and wind speed can help in reducing the impact of intermittent energy

Voltage and frequency fluctuation, and harmonics are major power quality issues for both grid-connected and stand-alone

systems with bigger impact in case of weak grid. This can be resolved to a large extent by having proper design, advanced fast response control facilities, and good optimization of the hybrid systems. The paper gave an overview of different research works related to optimal sizing design, power electronics topologies and control for grid-connected and stand-alone hybrid solar PV and wind systems. Solar PV and wind hybrid system can be connected in a common DC or common AC bus whether they are working in a grid-connected mode or a stand-alone mode.

References

[1] J. B. Fulzele and M. B. Daigavane, "Optimization of PV-wind Hybrid Renewable Energy System for Rural Electrification," *2015 7th International Conference on Emerging Trends in Engineering & Technology (ICETET)*, Kobe, 2015, pp. 101-105.