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An Application of PSO to Power Management in Photovoltaic Microgrids

R B R Prakash,

Department of Electrical and Electronics Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, AP, India

T Vijay Muni,

Department of Electrical and Electronics Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, AP, India

P Srinivasa Varma

Department of Electrical and Electronics Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, AP, India

Abstract:

Microgrids and distributed generation (DG) are becoming research priorities due to renewable energy's potential benefits. A microgrid usually has renewable microsources near the load Center. A microgrid needs a Voltage-Frequency control and Power management plan to govern each DG's real and reactive power. The load-sharing implications of adding renewable energy to the distribution system are examined in this study. GA-based MPPT for standalone photovoltaic (PV) array coupled to BESS is presented in this study. Maximum power point tracking (MPPT) Solar irradiation and temperature affect PV production. Due to the technology, PV output fluctuates, and nonlinear demand makes matters worse. PSO-based MPPT for PV generating works well for local optimization. DC/DC converters and boost converters were used to achieve the required rated voltage. A PI controller maintains DC-link voltage near its reference value regardless of external conditions.

1. Introduction:

Most of the world's energy needs is met by fossil fuels like oil, coal, and natural gas, which are depleting quickly. Burning these fuels releases carbon dioxide, which threatens life on Earth [1]. This is a major global warming problem.

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PV array systems will likely play a major part in energy production. PV systems convert sunlight into electricity. Fuel cells, wind generation, and solar systems require high step-up dc/dc converters to increase voltage. DC current becomes AC current. Photovoltaic (PV) energy conversion is a viable alternative to growing electricity demand and the high cost and limited availability of non-renewable sources because it does not pollute, is easily accessible, requires fewer resources, and has a low ownership and maintenance cost. Both grid-connected and standalone photovoltaic (PV) systems need growth. Photovoltaic (PV) electricity is expensive to install and vary by location, season, and weather. Run the system at MPP to maximize PV array power. It boosts PV system efficiency to maximize solar energy output.

When improving PV system performance, a high-efficiency power converter that extracts the most power from a PV panel is commonly considered. MPPT methods are also used. In most circumstances, the V-I curve has a Maximum Electricity Point (MPP). This is where the PV system is most efficient and produces the greatest electricity [5-17]. You may find the MPP utilising search engines or calculation models. Highest Power Point Tracking Techniques (MPPT) retain the PV array's operating point where it can generate the most power [26-28]. MPPT algorithm research has considered numerous techniques. P&O, lC, ANN, Fuzzy Logic, etc. P&O and IC are common. This study compares four MPPT algorithms: P&O, lC, fuzzy logic, and PSO. These low-cost methods are straightforward to adopt. Other techniques, like Sliding Mode [9], are more complex and infrequent.

This study offers a simulation model to construct and scale a hybrid system for different loads and conditions. Simulations using Matlab and SimPower Systems illustrate the system's efficiency. Figure 1 depicts the hybrid grid-connected system.

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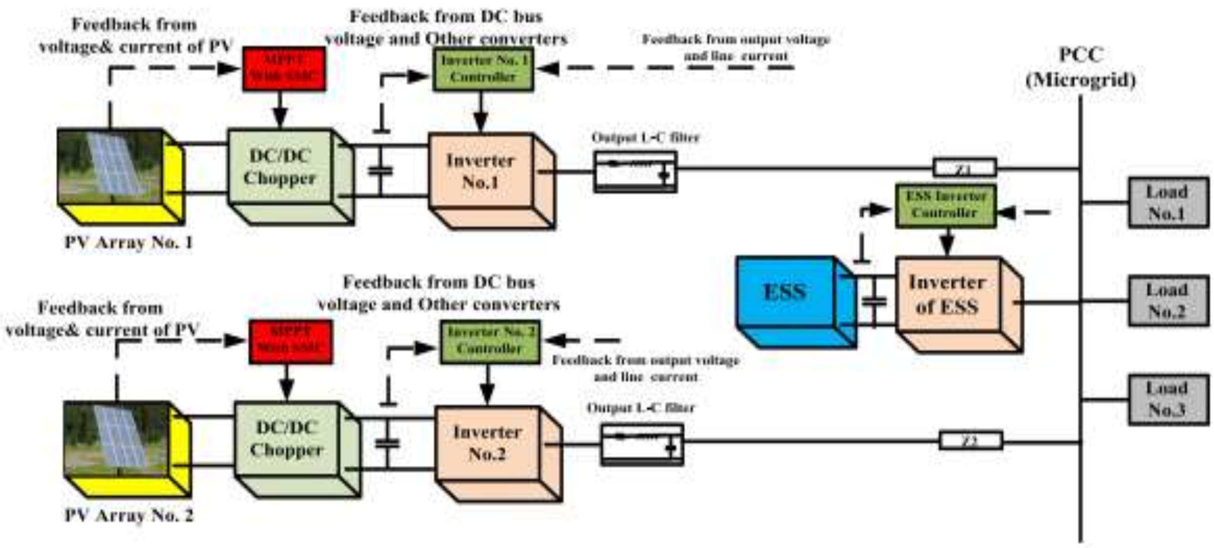

Figure 1: Configuration of proposed Parallel connected PV system

2. Solar System:

Solar cells are the foundation of photovoltaic (PV) systems. To generate current, voltage, and high power, PV array solar cells are coupled in series or parallel. Each solar cell has a semiconductor p-n junction, like a diode [5]. The photovoltaic effect generates current when light hits the junction. Figure 3 shows PV array output power characteristic curves at insulation level. Any output power characteristic curve must peak someplace. Figure 3 shows how solar intensity affects PV array (I-V) and (P-V) attributes. A forward-biased diode in parallel with the current source forms the solar cell's equivalent circuit. The output terminals are loaded. Solar cells currently follow this equation:

$$I = I_{ph} - I_D - I_{sh}$$

$$I = Iph - I_o\,[\exp\,(q\,V_D / nKT)] - (v_D / R_S)$$

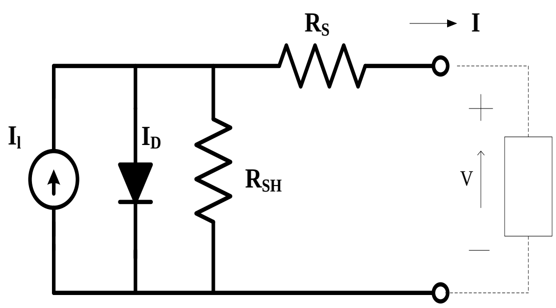

Figure 2: Equivalent circuit of PV Module

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Power output of solar cell is P = V * I

3. Maximum Power Point Tracking Method:

In PV system output power characteristics, irradiance and temperature curves are most essential. Solar radiation and temperature are also temporary constants. As noted, solar radiation levels will vary greatly during the day, as shown in Fig. 1. A typical solar panel converts 30% to 40% of solar energy into power. According to the Maximum Power Transfer theorem, a circuit's power output is maximized when its source impedance (thevenin) matches its load impedance. The maximum power point tracking method must be employed to increase solar panel efficiency.

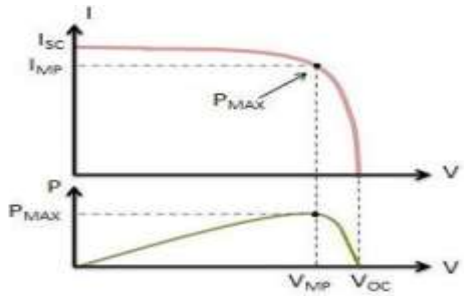

Figure 3: Output characteristics of PV Array

4. Incremental Conductance Method:

The slope of the current derivative with respect to voltage gives the maximum power point [2]. What practical value does MPPT offer given the array's location, weather, and seasonal load pattern? Current increases only when Vpp is more than 1V higher than battery voltage. This may not happen in warm temperatures unless the batteries are very low. Cold can raise Vpp to 18V. Heating expenses climb as temperatures decrease, and most families' energy demand peaks in winter. This could provide you a big energy boost when you need it most. A winter MPPT application:

The current ambient temperature is 20 degrees Fahrenheit (-7 degrees Celsius). The wind is blowing, so the maximum temperature of the PV cells is only around 32 degrees Fahrenheit, or 0 degrees Celsius. Vpp = 18V Due to limited battery life and active loads, the current battery voltage is 12.0. The battery voltage is 18 volts, whereas the power supply voltage is 12 volts, for a ratio of 1.5 to 1.

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A perfect MPPT (no voltage drop in the array circuit) would increase charge current by 50% under these conditions. Conversion losses are similar to transmission friction. Field reports show 20-30% increases.

5. Analysis of PSO Technique:

The typical PSO algorithm's convergence criterion is to maximise the number of successful iterations toward an optimum solution. In a PV system, however, the sweet spot moves around depending on factors like the weather and the load's resistance. Therefore, when the following conditions are met, the proposed PSO algorithm will re-initialize and begin searching for a new MPP.

$$\left| v(i+1) < \Delta v \right|$$

$$(pi(k+1) - pi(k) / pi(k) > \Delta p)$$

The new PV power is denoted by pi (k+1), whereas the old maximum power was denoted by pi (k). As can be seen in the aforementioned equations, and represent the agent's ability to detect convergence and a sudden change in insolation, respectively. Concerning the V option, there are two elements to consider:

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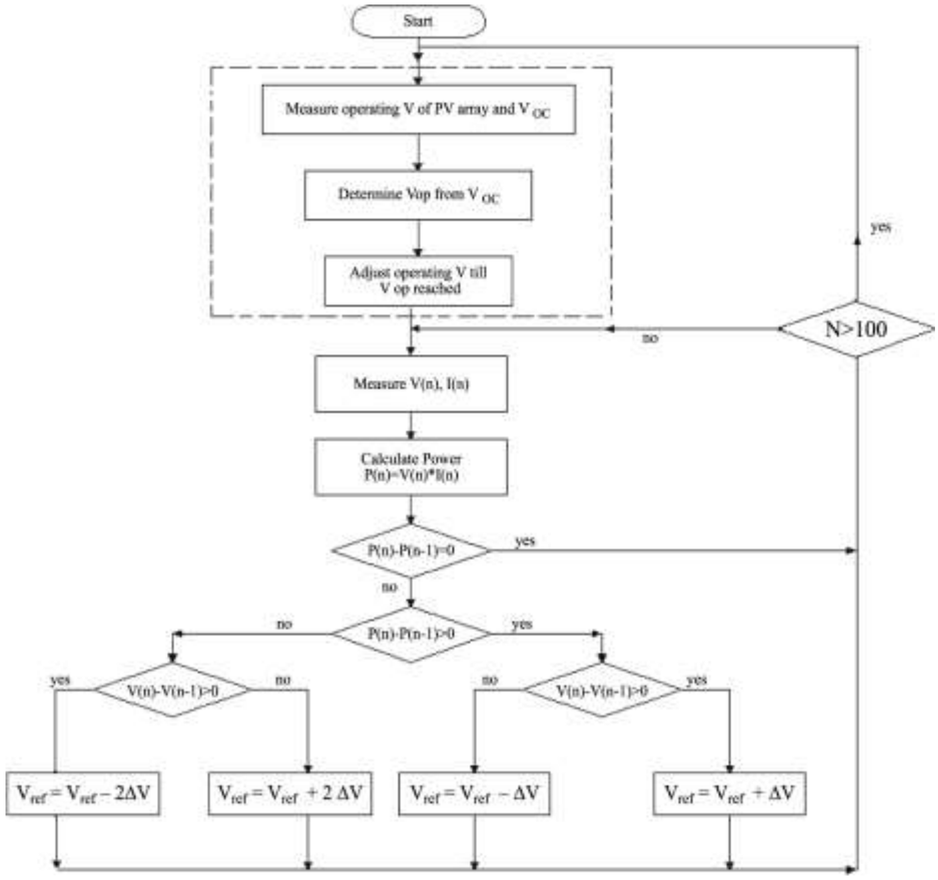

Figure 4: Incremental Conductance Method Algorithm

The new PV power is denoted by pi (k+1), whereas the old maximum power was denoted by pi (k). As can be seen in the aforementioned equations, and represent the agent's ability to detect convergence and a sudden change in insolation, respectively. Concerning the V option, there are two elements to consider:

There are two main outcomes: 1) lower values improve MPPT stiffness but slow tracking response, and 2) higher values improve tracking reaction speed but increase oscillations. Therefore, a rate that strikes a happy medium must be chosen. However, when P is large, the following constraint may not be satisfied due to smaller changes in real power; hence, the agents' rate of initialization is low.

Figure 5 shows the whole process flow for the suggested technique, and the following concepts form the basis of the proposed algorithm:

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Initial Step: Setting the Parameters The fitness value assessment function for the proposed MPPT algorithm is the power output from the PV modules, and the particle location is the computed duty cycle of the converter.

Activating the PSO, the second step: Particles in PSO are typically initialised at random in the conventional initialization. The particles in the proposed MPPT method are first seeded at predetermined, equally spaced coordinates around the GP.

Measurement of Physical Capacity, Step 3: Particle i's fitness is measured when the digital controller issues a PWM command based on the particle's duty cycle, which doubles as a representation of it's location.

Step 4: Find Your Personal Best and World Record Fitness: Particle values are re-evaluated in terms of their global and local best fitness (Pbest and gbest, respectively). If required, they are then replaced with other people in the same roles.

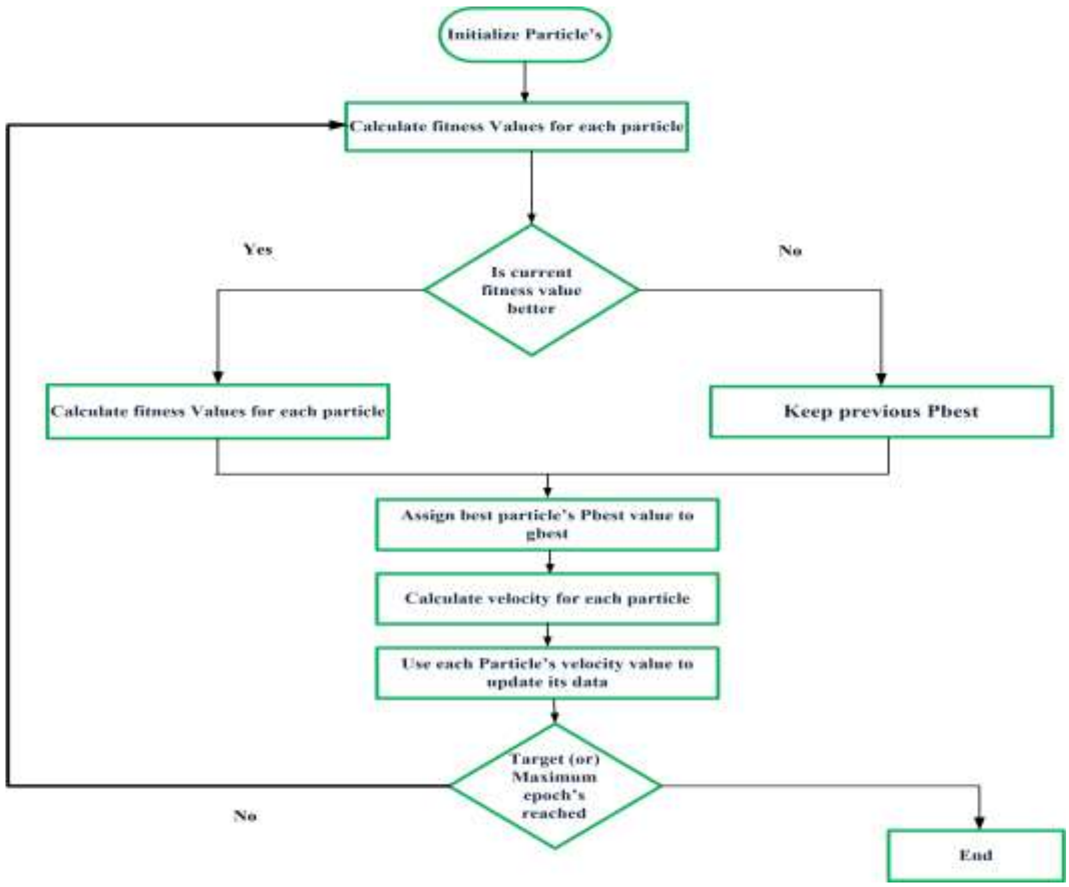

Figure 5. Algorithm for PSO Technique

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6. Energy Management Strategies and Power Flow Management

Batteries and supercapacitors are employed in grid-connected residential nano-grids. Batteries used to handle power fluctuations of grid-connected residential nano-grid systems in steady state have big capacity and energy density, whereas supercapacitors have huge power density and quick reaction. EMS-directed energy storage may smooth out distributed energy production and home load power variations to avoid tie-line power oscillations.

Figure 6 depicts the PV voltage reference. If MPPT is off, PV-curtail provides the PV voltage reference, and vice versa. The MPPT method defines PV power (PPV), whereas the PV-curtail algorithm defines (PPV). The power flow management method determines the PV voltage at the maximum power point (VPV,mpp), PV current at the maximum power point (IPV,mpp), and PV voltage and current during curtailment.

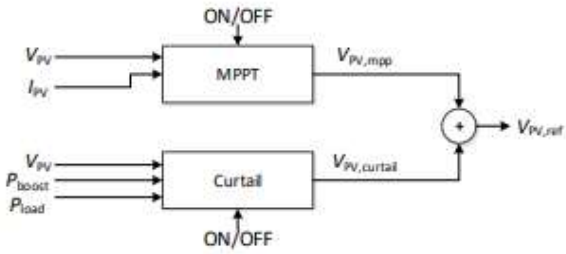

Figure 6: Control Structure for PMS System

7. Results and Discussion:

Figure 1 shows the whole parallel PV system in matlab. PV system has series-connected modules and a boost converter.

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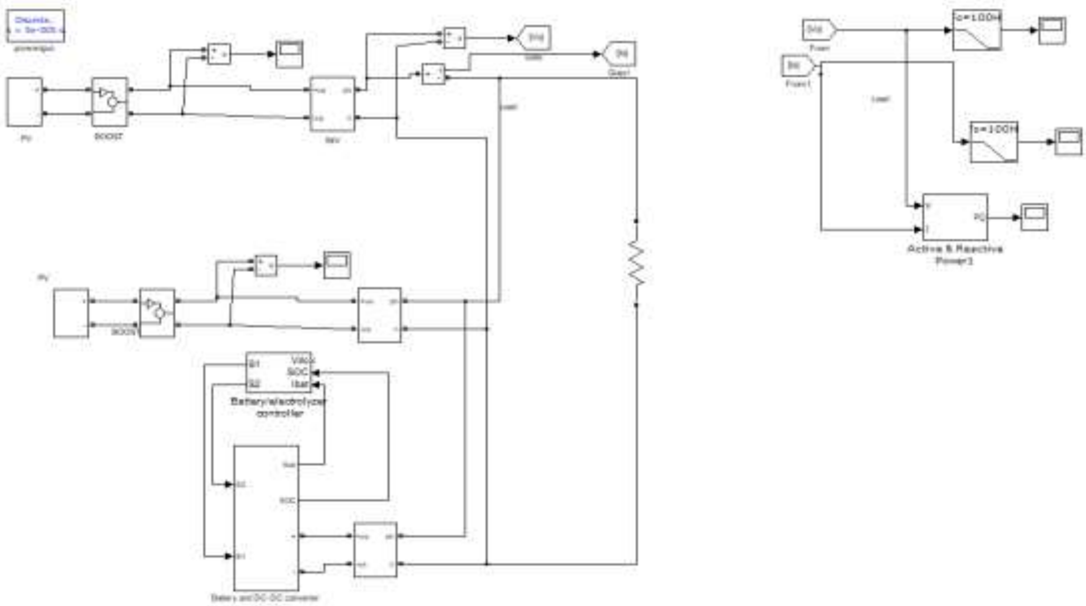

Figure 7: Simulation Diagram for Proposed Parallel Connected PV Systems

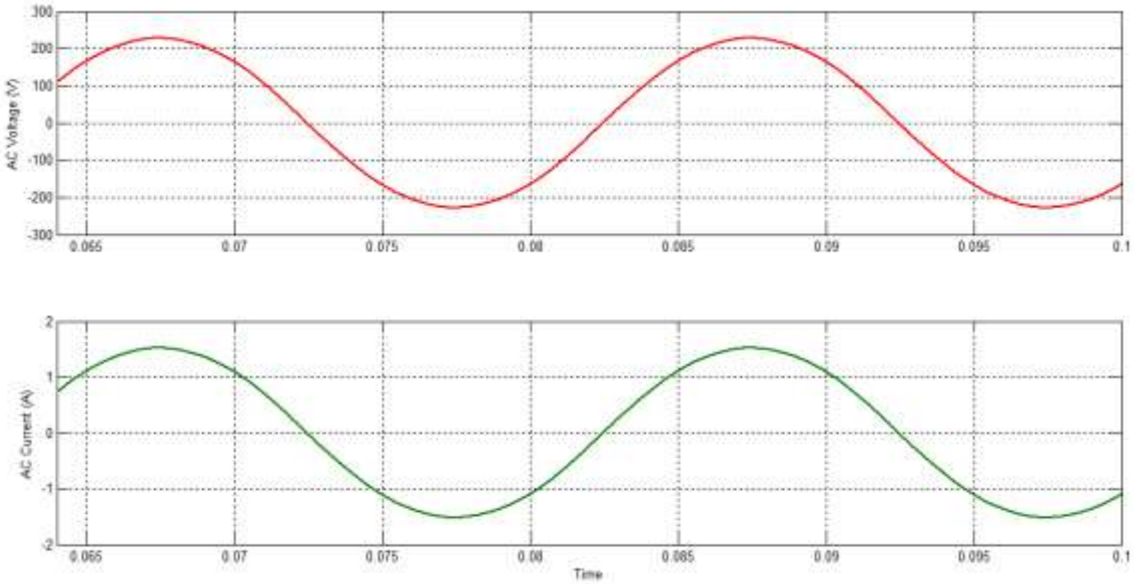

Figure 8: Simulation Result for AC Voltage and Current

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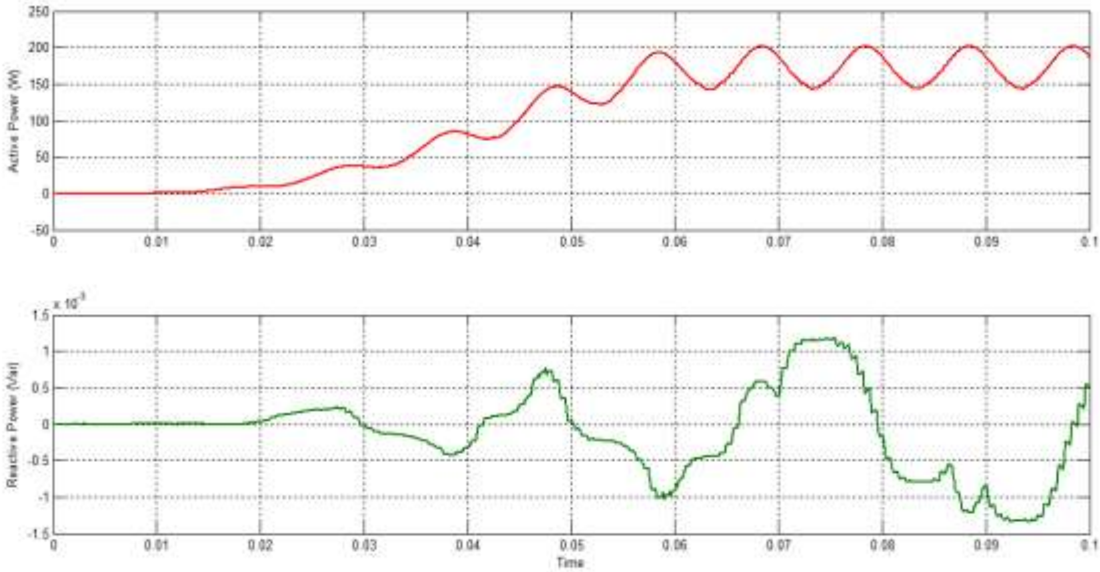

Figure 9: Simulation Result for Grid Active & Reactive Power

8. Conclusion

This review article classifies MPPT methods by control variable count. It specifies converter type and grid-tied or standalone mode for each MPPT technique. The latest hybrid MPPT methods and their benefits are covered in this article. MPPT users, PV system designers, and commercial manufacturers may benefit from this review. This research shows that INC and PSO are based on extreme value theory. If maximum value criteria are met, they should be able to precisely monitor the maximum power point. Both methods rely on numerical approximations of differentiation, which may be unstable and inaccurate in real-world applications due to noise and quantization error. A major difficulty with algorithms is that they cycle around the optimal operating point.

Test and analyze isolated power systems on MATLAB PC. Examining solar panels to meet the load has many benefits for hard-to-reach loads. Simple and affordable is the ideal arrangement. Linking disconnected power systems to the gird can meet their rising power needs. Overall, the isolated system operates better, is cheaper for rural areas to meet distant loads, and is more popular with consumers.

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Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 1, 2019

References

[1] R. Datta and V. T. Ranganathan, "Variable-speed wind power generation using doubly fed wound rotor induction machine—A comparison with alternative schemes," IEEE Trans. Energy Convers., vol. 17, no. 3, pp. 414–421, Sep. 2002.

[2] J. Arbi, M. J.-B. Ghorbal, I. Slama-Belkhodja, and L. Charaabi, "Direct virtual torque control for doubly fed induction generator grid connection," IEEE Trans. Ind. Appl., vol. 47, no. 1, pp. 4163–4173, Jan./Feb. 2011.

[3] Krishna Mohan Tatikonda, Chengzong Pang, S. V. P. K. Maddukuri and R. Uday Kishan, " Comparison of MPPT Techniques for SEPIC Converter Based Photovoltaic System," 2016 IEEE Online International Conference on Green Engineering and Technologies (IC-GET), 978-1-5090-4556-3/16/$31 .00 ©2016 IEEE.

[4] M. J. Hossain, H. P. Pota, V. A. Ugrinovskii, and R. A. Ramos, "Simultaneous STATCOM and pitch angle control for improved LVRT capability of fixed-speed wind turbines," IEEE Trans. Sustainable Energy, vol. 1, no. 3, pp. 142–151, Oct. 2010.

[5] A. Causebrook, D. J. Atkinson, and A. G. Jack, "Fault ride-through of large wind farms using series dynamic braking resistors," IEEE Trans. Power Syst., vol. 22, no. 3, pp. 966–975, Aug. 2007.

[6] M. E. Haque, M. Negnevitsky, and K. M. Muttaqi, "A novel control strategy for a variable-speed wind turbine with a permanent-magnet synchronous generator," IEEE Trans. Ind. Appl., vol. 46, no. 1, pp. 331–339,Jan./Feb 2010.

[7] T. Eswara Rao, Krishna Mohan Tatikonda, S. Elango, and J. Charan Kumar, "MICROGRID TECHNOLOGIES", Edited by C. Sharmeela, P. Sivaraman, P. Sanjeevikumar, and Jens Bo Holm-Nielsen, Scrivener Publishing, ISBN: 9781119710790.

[8] C. S. Brune, R. Spee, and K. Wallace, "Experimental evaluation of a ´ variable-speed doubly-fed wind-power generation system," IEEE Trans. Ind. Appl., vol. 30, no. 3, pp. 648–655, May/Jun. 1994.

[9] S. Bhowmik, R. Spee, and J. H. R. Enslin, "Performance optimization ´ for doubly fed wind power generation systems," IEEE Trans. Ind. Appl., vol. 35, no. 4, pp. 949–958, Jul/Aug. 1999.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 1, 2019

[10] Dr. V. Praveen, Ch. Rajesh, I. Naga Sai Prathyusha, B. Pavan Kumar, Sk. Sariya, "Super conducting magnetic energy storage based dvr using fuzzy-logic controller", International Journal of Management, Technology And Engineering, 2019.

[11] Y. Rajendra Babu, C. Srinivasa Rao, "Distributed generation integration to transmission grid Controlled with d-q theory", Arpn journal of engineering and applied sciences, 2017.

[12] Krishna Mohan Tatikonda, Udaya K. Renduchintala, Chengzong Pang, and Lin Yang, " ANFIS- fuzzy logic based UPQC in interconnected microgrid distribution systems: Modeling, simulation and implementation," 2018 The Authors. The Journal of Engineering published by John Wiley & Sons Ltd on behalf of The Institution of Engineering and Technology, https://doi.org/10.1049/tje2.12005.

[13] S. Muller, M. Deicke, and R. W. De Doncker, "Doubly fed induction ¨ generator systems for wind turbines," IEEE Ind. Appl. Mag., vol. 8, no. 3, pp. 26–33, May/Jun. 2002.

[14] G. D. Marques and D. M. Sousa, "Air-gap-power-vector-based sensor less method for DFIG control without flux estimator," IEEE Trans. Ind. Electron., vol. 58, no. 10, pp. 4717–4726, Oct. 2011.

[15] K. Lakshmi Ganesh, N. Saida Naik, K. Narendra, G. Satya Narayana, "A Newly Designed Asymmetrical Multi-Cell Cascaded Multilevel Inverter for Distributed Renewable Energy Resources", IJRTE, 2019.

[16] A.Sekhar Sunil,Y.Anne janet,N.Mounica"A Cascaded H-Bridge Multilevel Inverter Using Switched Parallel DC Voltage Sources"2017 International Journal for Modern Trends in Science and Technology.

[17] A.Sekhar Sunil,S.Priyanka and K.Tejaswi "A Control Method for UPQC Based on SRF Theory Under Unbalanced and Distorted Load Conditions "2017 International Journal for Modern Trends in Science and Technology.