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ADVANCED CONTROL STRATEGY FOR PMSG BASED WIND ENERGY CONVERSION SYSTEM

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Abstract-The paper presents the advanced management system of the wind energy conversion with a variable speed wind turbine. Permanent-magnet synchronous generators (PMSG) are used extensively in wind turbine purposes. The efficiency evaluation of PMSG might be enhanced by adopting various management mechanisms with the advantage of advanced ANN techniques. Renewable energy is harnessed from constantly replenishing natural processes. The concentrate on renewable power has over the previous few many years intensified tremendously. This paper response of the developed Liebenberg based Artificial Intelligence Technique based MPPT algorithms for wind system with multilevel converter interfaced PMSG based wind energy conversion system. The PMSG is used as a variable speed generator and related on to the turbine without gearbox.
Keywords: Wind turbine, PMSG generator, MPPT control, pitch control.

1. INTRODUCTION

The functions of wind energy conversion systems (WECS) have elevated considerably in recent times. The growing development is to stimulate analysis within the area of energy conversion with a purpose to optimize the acquiring of the most important values of energy from wind generators. The utilized methods of wind generators may be categorized into fixed pace and variable velocity generators. The variable velocity turbine programs at the moment are extra typically utilized then the programs with fixed velocity. The predominant benefits of variable pace programs are: growing the manufacturing of wind vitality, the flexibility to realize most vitality conversion effectively and discount of mechanical stresses [1].
Most of the primary wind turbine manufacturers develop methods primarily based on variable velocity wind generators. The efficiency of the wind energy programs may be significantly enhanced with the usage of a full-capacity converter system [2]. With the usage of these kind of energy converter methods, the generator is totally decoupled from the grid and might function in full velocity range. In these trendy kinds of wind energy conversion methods the permanent magnet synchronous generators (PMSG) have been extensively used [3].
The PMSG generator may be constructed with a lot of poles and may be operated because the direct-driven system without a gearbox. This ends in a reduction of set up and maintenance prices and gives an advantage over the opposite kinds of generators [4].
This paper presents a novel control strategy to produce a steady energy with the robust wind circumstances. Pitch angle and rotational velocity management system are proposed to function the wind turbine throughout excessive wind velocity [5]. In proposed methodology, the PMSG primarily based WECS can briefly tolerate the wind pace up40 to 35 m/s. As a consequence, the WECS can generate energy throughout the robust wind situation which could be very helpful particularly within the typhoon-affected areas. The effectiveness of simulation for proposed method is verified by MATLAB/Sim Power Systems environment.

2. MATERIALS AND METHODOLOGY

An illustration of a Wind energy conversion system is proven in Fig. 2.1 Wind energy is transformed into electrical energy by the PMSG. This energy is provided to the grid by means of the generator aspect converter and grid aspect inverter. The generator aspect converter controls the rotational pace, in addition to the output energy of the PMSG. The system after the DC link is modeled as a voltage source as a result of the system is similar as a standard system.

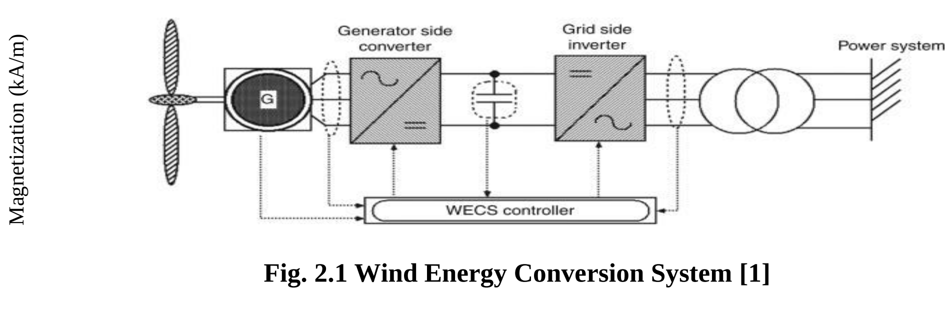


Fig. 2.1 Wind Energy Conversion System [1]

3. ARTIFICIAL NEURAL NETWORKS (ANN) IMPLEMENTATION

Artificial Neural Networks (ANN) are massively parallel interconnected networks of simple organizations (processing elements) which are intended to interact with the objects of real work in the same way as the biological neural system do.
These parallel distributed models are potentially capable of performing non-linear modeling and adaptation without any assumptions about the model. In very broad terms, the ANN may be defined as an attempt to capture the human brains capabilities for solving complex problem.

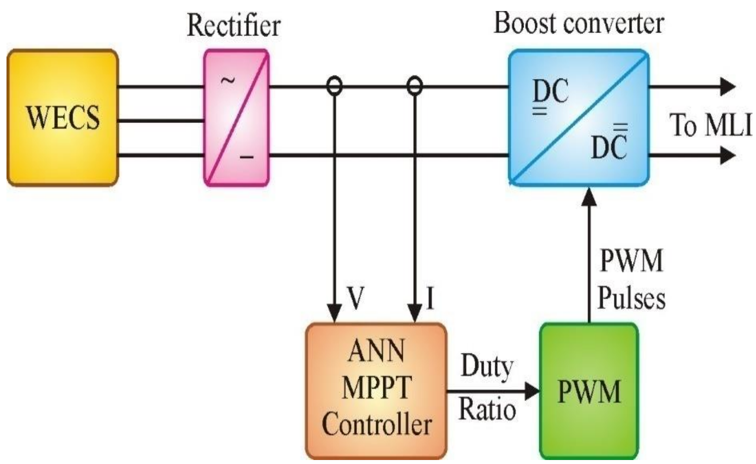


Fig. 3.1 Block Diagram of ANN MPPT Controller

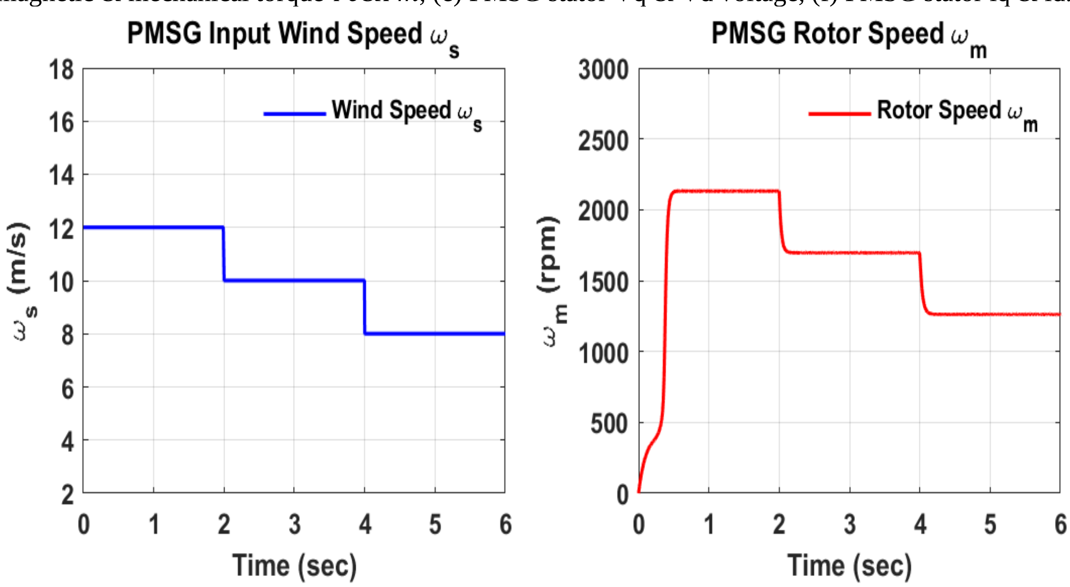
Fig. 3.1 Shows the ANN consists of several artificial neurons that are connected through variable weights connections. Basic Architecture of the ANN consists of three layers as an input layer, hidden layer and output layer. The neural network for a wind system consists of two input variables; voltage and current. Hidden layer consists of 15 neurons.

4. SIMULATION RESULT AND ANALYSIS

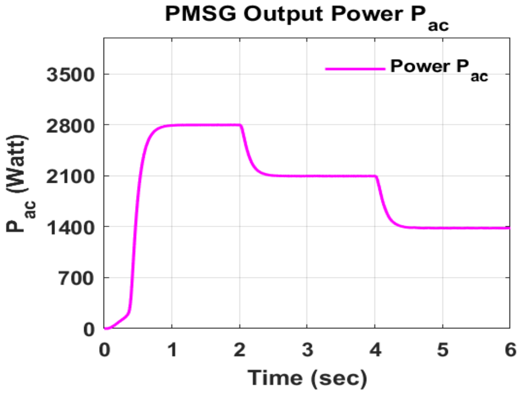
In the response of the developed Liebenberg based Artificial Intelligence Technique based MPPT algorithms for wind system with multilevel converter interfaced PMSG based wind energy conversion system in MATLAB/Simulink environment to validate the reliability and stability under different input/output conditions.

4.1 Simulation Response at Varying Wind Speed of 12-10-8 m/s

In Fig. 4.1 shows Simulation results for PMSG based WECS for varying input wind speed of 12-10-8 m/s with MPPT, Waveform of, (a) input wind speed ωs, (b) PMSG speed ωm, (c) PMSG output power Pac, (d) Electromagnetic & mechanical torque $Te\&Tm$, (e) PMSG stator Vq & Vd voltage, (f) PMSG stator iq & id.



(a) (b)



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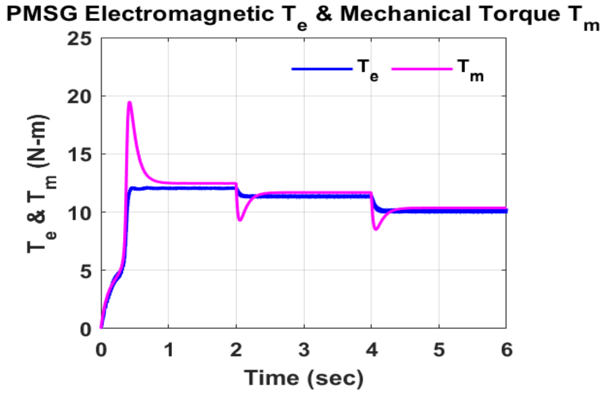

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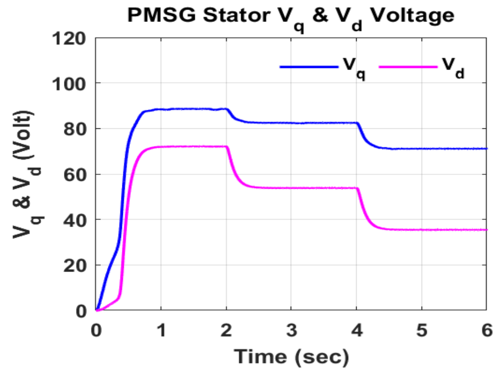

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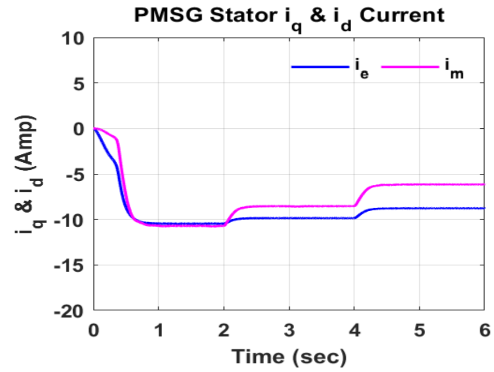
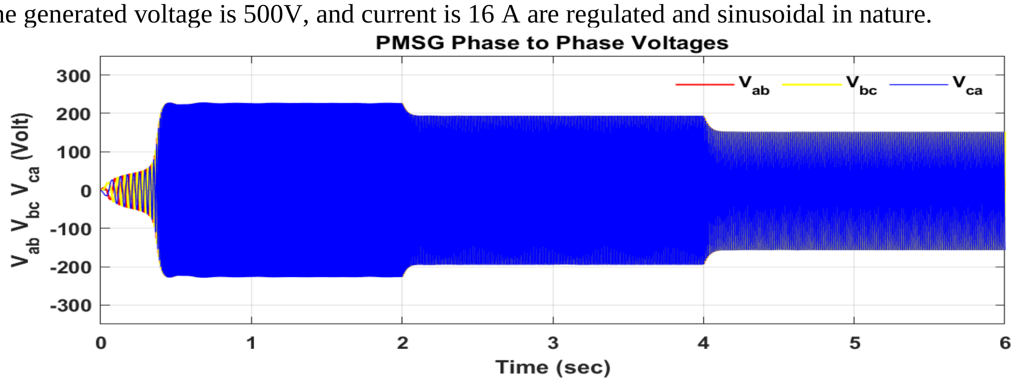


(f)

Fig. 4.1 Simulation results for PMSG based WECS for varying input wind speed of 12-10-8 m/s with MPPT, Waveform of, (a) input wind speed ωs, (b) PMSG speed ωm, (c) PMSG output power Pac, (d) Electromagnetic & mechanical torque $Te\&Tm$, (e) PMSG stator V_q& V_d voltage, (f) PMSG stator i_q & i_d

In Fig. 4.2 shows Simulation results for PMSG based WECS for varying input wind speed of 12-10-8 m/s with MPPT the generated voltage is 500V, and current is 16 A are regulated and sinusoidal in nature.



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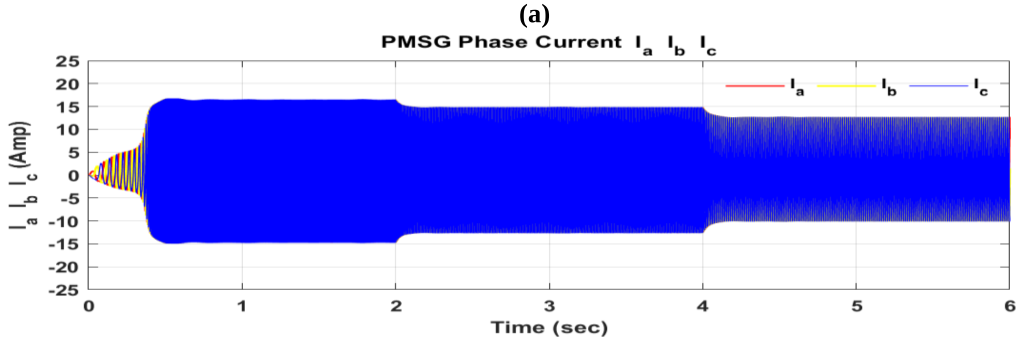
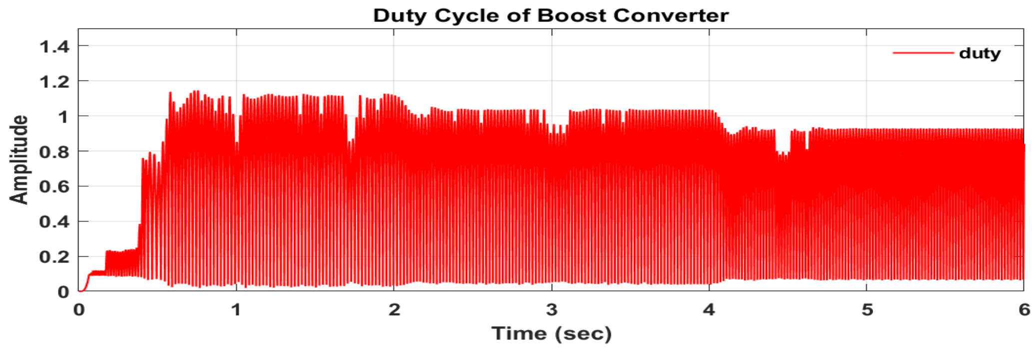


(b)

Fig. 4.2 Simulation results for PMSG based WECS for varying input wind speed of 12-10-8 m/s with MPPT, Waveform of, (a) PMSG phase to phase voltages Vab $VbcVca$, and (b) PMSG phase current $IaIbIc$



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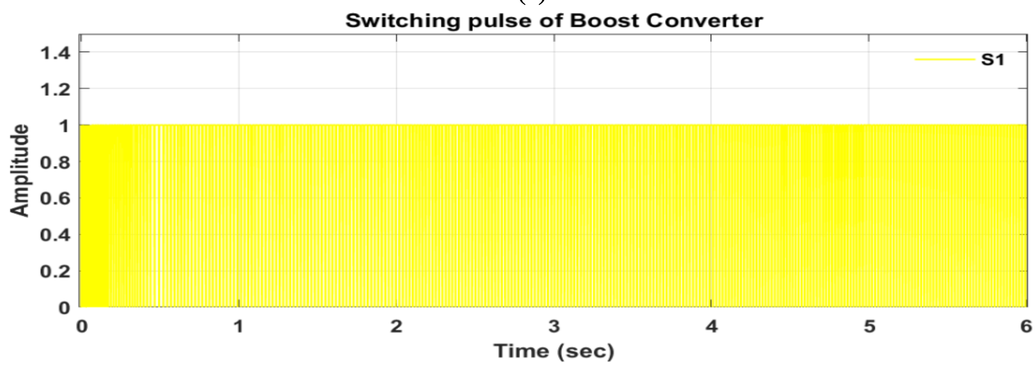

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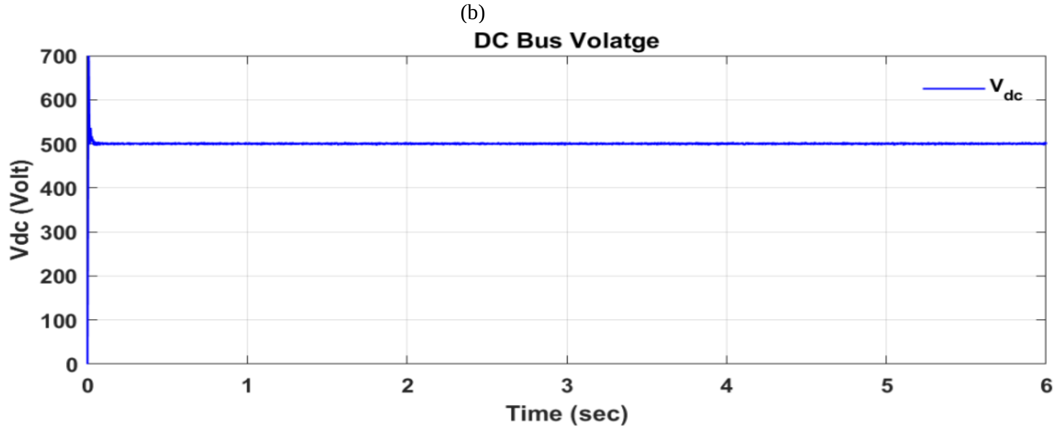
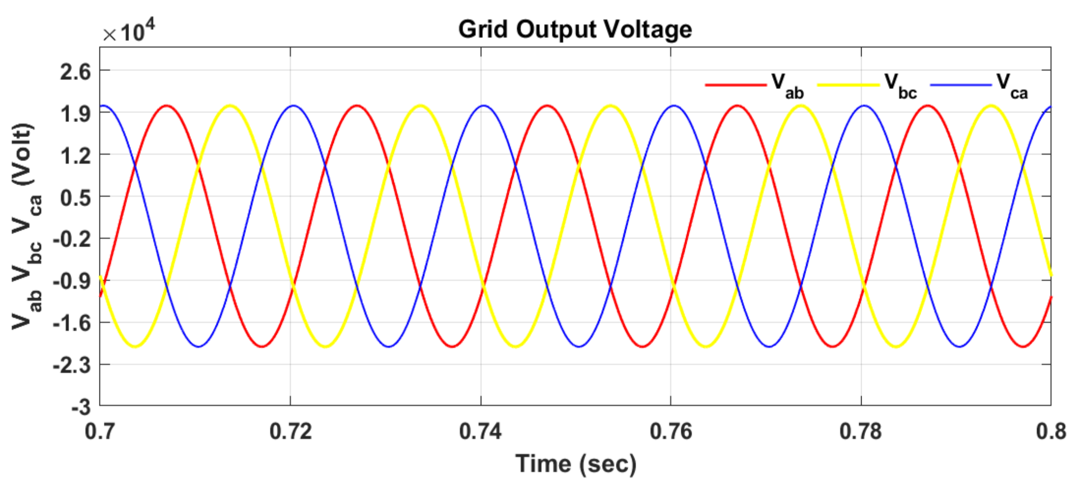


(c)

Fig. 4.3 Simulation results of boost converter system, Waveform of, (a) Duty cycle, (b) Switching pulses of switch S1, and (c) DC bus voltage.

In Fig. 4.4 shows Simulation Results for Grid, Waveform of (a) Phase-Phase Voltage and, (b) Phase current.



(a)

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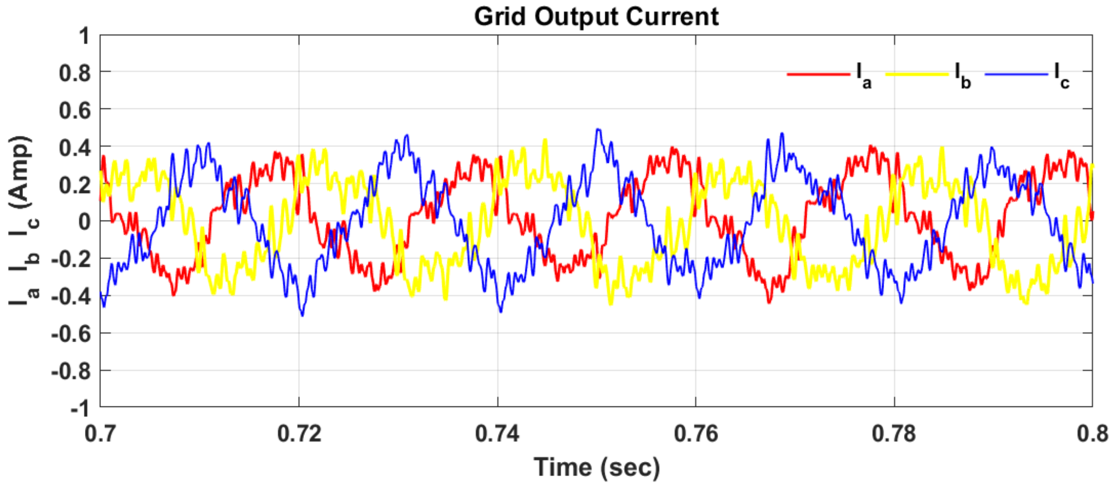

(b)

Fig. 4.4 Simulation Results for Grid, Waveform of (a) Phase-Phase Voltage and, (b) Phase Current

CONCLUSION

This Paper presents intimately the response of the developed Liebenberg primarily based Artificial Intelligence Technique based MPPT algorithms for wind system with multilevel converter interfaced PMSG based wind energy conversion system in MATLAB/Simulink environment to validate the reliability and stability below completely different input/output situations. Here presents Simulation outcomes for PMSG primarily based WECS for various input wind speed of 12-10-8 m/s with MPPT. Also presents the waveform of phase to phase voltage and phase current when enhance the wind speed 12 to 10 to 8 m/s.

REFERENCES

[1] Hidehito Matayoshi, Abdul Motin Howlader, Manoj Datta and Tomonobu Senjyu, "Control Strategy of PMSG Based Wind Energy Conversion System Under Strong Wind Conditions," Energy for Sustainable Development, DOI: 10.1016/j.esd.2018.07.001, pp. 1-22, 2019.

[2] Piotr Gajewski, Krzysztof Pie Kowski, "Advanced control of direct-driven PMSG generator in wind turbine system," Archives of Electrical Engineering, vol. 65(4), pp. 643-656, July 2016.

[3] Shariatpanah, H., Fadaeinedjad, R., and Rashidinejad, M. "A new model for PMSG-based wind turbine with yaw control," IEEE Transactions on Energy Conversion, vol 28(4), pp. 929-937, 2013.

[4] Yi-Nan Zhang, Hui-Jing Cao, Ming-Ming Zhang, "Investigation of leading-edge protuberances for the performance improvement of thick wind turbine airfoil1," Journal of Wind Engineering & Industrial Aerodynamics, vol 217, pp. 1-12, 2021.

[5] A. M. Howlader, N. Urasaki, A. Yona, T. Senjyu and A. Saber, "A review of output power smoothing methods for wind energy conversion systems Renew Sustain," Energy Reviews, vol 26, pp. 135-146, 2013.

[6] Toshihisa Funabashi, "Integration of Distributed Energy Resources in Power Systems," Academic Press, pp. 1-14, 2016.