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Matrix Converter Based Maximum Power Extraction through Wind Turbine and Induction Machine

Chetan Ghatage, S.Sumathi

***Abstract:** Wind power extraction has found an expressive growth in the past few years. This work endeavors on maximum utility power generation from wind resource and fulfill the needs of the society. Power extraction is composed of wind turbine (WT), induction machine (IM) and matrix converter (MC) forms a system of wind energy conversion (WECS). The stator and rotor synchronous speed of the IM is controlled by adjusting the frequency using MC for different given wind speeds. As the power accessible from induction generator (IG) is a component of WT shaft speed, so that maximum power is extracted by changing frequency for different wind speeds. MC acts as bridge between the grid and induction generator to confirm purely active generated power injection to the grid and maintains power factor at unity (UPF) at the grid side. To track and extract the maximum power for different wind velocities based on constant voltage/frequency control strategy to regulate the shaft speed of IM accordingly is presented. The effective maximum power generation is supported by simulation results and analysis with respect to WT characteristics is proposed.*

***Keywords:** WECS, MC, WT, IM, IG, SVM, SCIG*

I. INTRODUCTION

Because of increasing attention on renewable electrical energy generation, a significant quantity of exertion is being made to produce power from new source of vitality. Wind energy generation is the one among the green energy resource which helps in minimizing the fossil fuel burning in power plants for producing power. Research was focused on manufacture of modern wind turbines with different capacity for global net power demand. Wind Power can be harnessed by a WECS, where wind blades movement will provide kinetic energy which is converted to electric power and injects this power generated into a grid utility. This system involves a wind turbine, asynchronous generator, a gear box, a controlling method to connect grid is as appeared in Fig 1 [1] .

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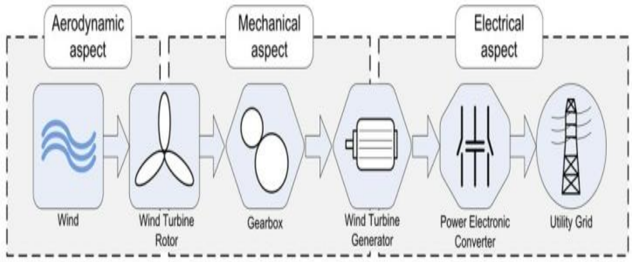

Fig. 1: WECS [1]

The various kinds of wind turbine systems have been developed built on the usage of various sort of, generators, control approaches, wind turbine rotors and power-electronic converters. WT systems are alienated into two assemblies, based on the orientation axis of rotation along with wind path, specifically Vertical axis turbine and Horizontal axis turbine. The moment the wind starts blowing, it rotates the WT blades, that's turns the IG rotor, which helps in producing electricity thereafter. The power output of WT is associated into two parameters: speed at which of the wind blows and rotor size. The power generated is corresponding to the third order wind speed, expecting every other parameter are consistent. Hence, the yield power generation of WT will build all the more significantly as wind blow speed increments. Bigger rotors enable turbines to capture more wind, along these lines expanding their yield power vitality. The wind vitality turns a few propeller-like sharp blades which are associated with rotor. The rotor is associated with the principle shaft, which turns a generator to deliver power.

The P_T and T_T on the rotor shaft of the WT is given by (1) and (2) [2]

$$P_T=0.5 * Cp(\beta,\lambda) * \rho * A_r * V^3 \quad (1)$$

$$T_T = 0.5\omega_T * Cp(\beta,\lambda) * \rho * A_r * V^3 \quad (2)$$

Where the parameters designated as

P_T = Turbine rotor power (mechanical),
T_T = Turbine rotor torque (mechanical),
A_r = Rotor area= πR^2 (R is turbine radius of the rotor)
V = velocity of wind [m/s],
Cp = Coefficient of performance and power
ρ = Density of Air measured in kg/m3
λ = Ratio of tip speed rotor (TSR),
β = Angle of the pitch rotor blade [rad],
ω_T = Angular speed turbine shaft [rad /sec].

The TSR, is given by λ = speed of the tip rotor blade/Wind speed =(R ω_T) / V. The co-efficient of power (Cp) is associated to the TSR and angle of the pitch β. Fig.2 [2] illustrations a distinctive Cp versus TSR curve. The theoretic higher edge of Cp value is 0.59 which is based on Betz's Law; its real-time range of difference is between 0.2 to 0.4.

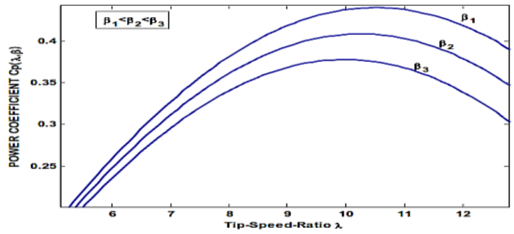

Fig. 2: A typical coefficient of power versus Tip and speed ratio curve [2]

The motivation behind an electrical energy generation is giving an approach to essentialness to energy transformation between the TT from the WT of WECS, and the load of electrical grid. Different sorts of generators are being utilized with WT. The typical types of Alternating current generator that are reasonable for present day WT structures are as per the following : squirrel cage IG, Wound-Rotor IG (WRIG), Doubly Fed IG, Synchronous type Generator field (external excitation), and Synchronous Generator with permanent magnet type [10].

IG has been broadly comprehensively utilized in business WT units for more power extraction. Induction generators are worked in asynchronous mode having advantage for application in WT bases, since it gives some level of adaptability when the wind speed is altering. There are two essential sorts of IG: Squirrel cage type of IG (SCIG) and Wound rotor type IG. Another class of IG is the doubly type fed IG (DFIG). The DFIG may be built on the SCIG or wound-rotor type IG.[16]

The IG constructed on SCIG is a very renowned machine because its low cost and eases operation, simple mechanical structures, strong assembly, and resistance with respect to changes in more aggravation and vibration. The generator speed matches with WT with the help of gearbox. The utilization of gear box is subject to various kinds of power generator utilized in WECS. The control techniques made for WECS are typically divide into two main groupings: Constant and Variable speed methodologies [11].

In steady speed WT, the turbine shaft speed cannot be controlled. Steady speed control is simple, basic and less cost, minimal effort technique, but variable factor speed the accompanying focal points: Extreme power extraction for getting the maximum probable energy, Lower value of mechanical assembly pressure, fewer contrasts in electrical aspects of power, and nominal acoustical method to production of noise at lesser wind speed variations.

During WT process, few fluctuations may arise due to system components of mechanical or electrical portions. The changes in fluctuations identified with regard to the mechanical parts incorporate current variations formed by the WT blades passing through the particular tower and variable wind speed produced by different current amplitudes. The varieties identified with the electrical portions, for example electrical power converter causes voltage harmonics. Present day WECS has a significant role with variable-speed control technique of PE converter. The basic difficulties for the power electronic methods of converters and controlling methods in variable (inconstant) speed system of WECS are: Getting more power from the wind source, whenever speed of the wind fluctuates, by supervisory control of the rotor speed of the WT. and the AC output from the power generator having some modification in the variable frequency value and variable change in magnitude can be changed to a steady frequency value and stable magnitude supply, which can be sustained to the an electrical type of grid.

PE converters are these days getting progressively appealing in improving the best performance of WECS [12]. It merits referencing that the power moving through the PE converter is reliant on the configuration and structure of WECS. The most widely recognized converter formation in variable speed WT is MC, which performances as direct AC/AC converter. MC is composed of nine switches which acts as bidirectional devices as one-stage AC/AC converter (mainly IGBTS), interfacing each input phase to a particular output phase [9]. MC structure is shown in Fig. 3.

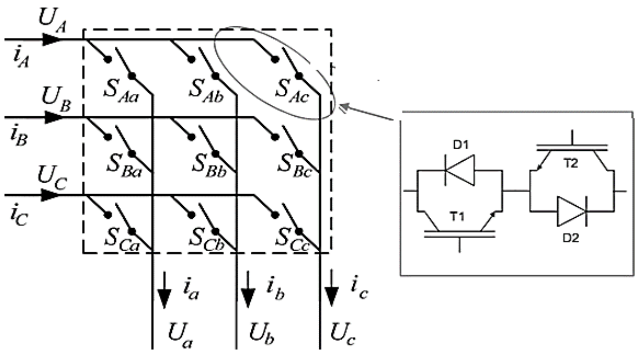

Fig. 3: MC Structure [3]

It gives sinusoidal input information and yields sinusoidal output waveforms, with insignificant fewer subharmonic and produces negligible harmonics in higher order. It has characteristics of bidirectional flow of energy and IPF can be controlled very effectively. The output voltage is produced from the input voltage directly as there is no existence of energy storage component present between input and output of a MC. In this strategy by sequential piecewise sampling process output voltage of MC is synthesized [12].

The fundamental thought behind MC is that a required output voltage and frequency can be initiated by properly working the switches that interface the input terminals of the MC to its output terminals. MC application in power extraction from wind, utilizing SCIG is evolving as a vital innovative knowledge for supply of power from IG into grid.

In this work, WECS built on grid connected MC, which controls SCIG coupled to a WT have been projected. A controlling method to operate switches at particular intervals a SVM technique is used [8]. SVM method involved MC has been adjusted for controlling the working of the SCIG to accomplish control on stator frequency and its voltage during power generation. A MC which is constructed on an array of controlled two directional switches to produce maximum power using SVM method for the different wind speeds [5].

II. RESEARCH METHODOLOGY

Wind energy conversion system research work goals to examine the utilization of MC using different controlling methods for two reasons, MC is an developing and inventive innovation with progressively capability with more potential of replacing rectifier(AC to DC)-inverter(DC to AC) pair, and no detail study of converter on this application not been studied and implemented. The main principle approach of this paper is to develop a 1MW power plant with variable speed wind turbine framework utilizing a MC and an IG.

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In this method, the MC is adopted to regulate the two powers active as well as reactive, which is transferred in to grid. Control of the induction machine connected to a wind system based on frequency control of the stator using SVM method matrix converter. Extracting maximum power from the IG by varying control variables of MC. A WECS created on a SCIG and an MC is proposed. Fig.4 demonstrates the block diagram of the proposed WECS with frequency control of stator using MC.

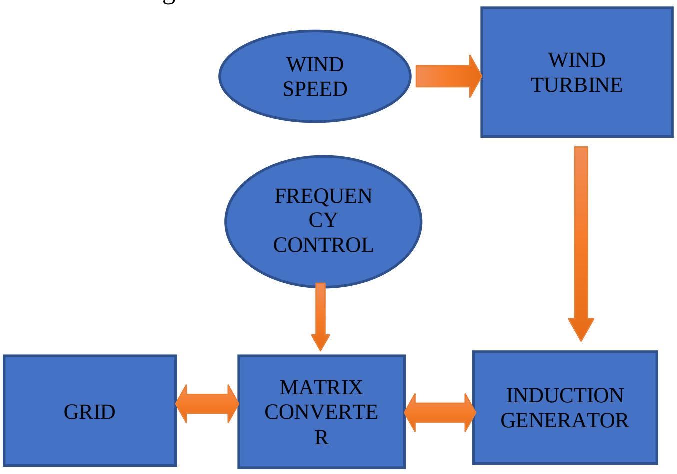

Fig. 4: Frequency Control for Induction Generator

The theoretical graph of turbine wind speed versus turbine power is for distinct wind speed is as shown in Fig 5 [2]. Wind Turbines systems are designed for more than 3-4m/s wind speed as the power developed is less. The rated speed for the turbine speed and turbine output power characteristics is at 9m/s. The pitch control system or stall regulator limits rated value of power, when wind speed exceeds the 9m/s to avoid the high mechanical loads [7].

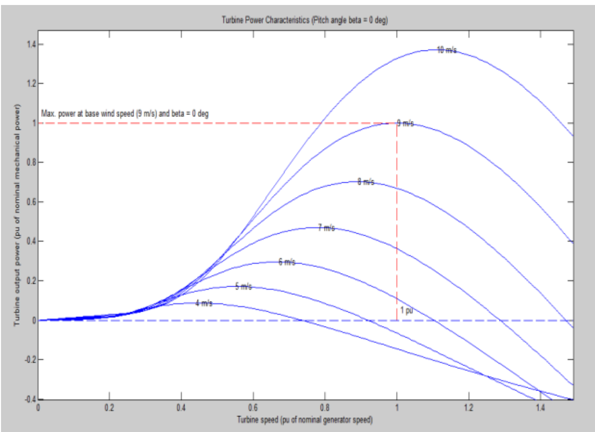

Fig. 5: Torque Speed Vs Turbine Output Power [6]

The WT and IG model is as portrayed in Fig 6 [20]. The rotor is driven by the WT and the stator winding of IG is associated with the grid by connecting MC as a intermediate stage. The power captured by the WT which rotates the rotor of IG to produce electrical power by controlling the stator frequency. The power captured from IG is transferred in to the grid from stator winding of IG. The pitch of angle controller is used in direction to limit the IG output power when it exceeds the rated readings for higher wind speeds. The IG speed should be more than the synchronous speed in order to generate power. A, B and C indicates the input terminals of the WT and IG. Trip depicts logical signal 0 or 1 as input. When TRIP input resembles high signal it indicates WT and IG is disconnected. Wind (m/s) reflects the input of the wind speed in meters per second to the system. WTIG Simulink output vector produces eight output parameters. WTIG Simulink output contains 8 internal signals (m) based on generator rating listed in Table 1.

Table 1: Parameter Description of WTIG [20]

Signal	Signal Names	Definition
1	Vabc (pu)	Phase to ground phasor voltages namely Va, Vb and Vc in terms of pu
2	Iabc (pu)	Ia, Ib and Ic are phasor currents measured in pu
3	P (pu)	Power output measured in pu. positive value of power indicates generation and is injected in to the grid
4	Q (pu)	Reactive power output measured in pu. A positive reactive output indicates power generation.
5	wr (pu)	Rotor speed of a generator measured in pu
6	Tm (pu)	Machine driven torque applied to the IG measured in pu.
7	Te (pu)	Torque from electromagnet calculated in pu
8	Pitch angle (deg)	Pitch of angle with blade in degrees.

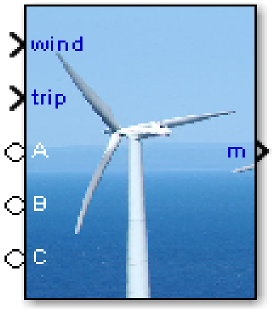

Fig.6: WT and IG

The wind turbine parameters are listed in Table 2.

Table 2:Wind Turbine Characteristics [20]

SL.NO.	PARAMETERS	VALUES
1	Pitch of angle with the blades (deg)	0
2	The mechanical power output of nominal turbine in watts(W)	1MW
3	The base wind speed (m/s) at rated value	9
4	Base speed rotation (minimum in pu)	1

5	The base of wind speed power (maximum in pu)	1
6	Controller gain (Pitch angle measurement as Kp Ki)	5,25
7	Maximum pitch of angle (maximum in deg)	45
8	Pitch angle change (maximum rate)	2

The SCIG is a robust, cost effective and powerful machine appliance having best performance for particular applications in the industry. Likewise, the IG has high reliability and quality output mechanical possessions for WT, which makes the slip and overload capability in some degrees depending on the power extraction. Therefore SCIG is used in the proposed in this system for extracting the power from wind turbines. The IG specifications are as shown in Table 3.

Table 3: IG Specifications [20]

SL.NO.	PARAMETERS	VALUES
1	Nominal power (nominal value in Pn(VA):	1MW
2	Voltage measured in line to line is Vn measured as Vrms	575V
3	Frequency is fn measured in Hz	60Hz
4	Resistance of stator is Rs and Inductance leakage is Lls calculated in terms of pu	0.004843,0.1248
5	The rotor resistance of rotor is Rr' and Inductance leakage is Llr',measured in pu	0.004377,,0.1791
6	Magnetizing value of Inductance as Lm measured in pu	6.77
7	Inertia [H(s)]	5
8	Factor value of friction F(pu)]	0.01
9	Pairswith respect to poles[p]	3
10	Slip as S, electrical variation angle measured in degrees, magnitude of stator current and phase of angle.	-0.01,0, 0,0,0, 0,0,0

MC is a one among the power converter having nine bidirectional IGBT switches are used [12]. It can be standard structure with a full-silicon with a compact design. MC acts as an intermediate between SCIG and Grid to match the frequency and voltage. MC connects the SCIG with the grid to implement control of shaft speed. In the projected system, the MC takes the input from the grid and the IG terminals are connected as output to MC. It is allows independent control of the output voltage and controllable stator frequency of IG. MC removes of the intermediate dc-link, along with different higher values of capacitors. The simulation model of grid connected MC is as represented in Fig.6 [17].

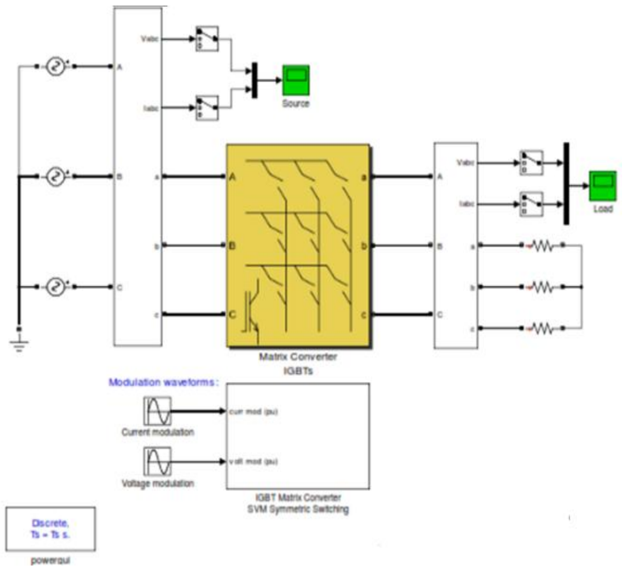

Fig. 6: Simulation model of MC connected to grid [18]

The pulse width modulation with space vector (SVPWM) is method can be implemented to control the switching operation of nine bidirectional switches in an MC [16]. It offers a various helpful features such as it signifies two dimensional reference frames with voltages or currents instead of considering three dimensional frames (abc). It decreases the number of switching in each period and provides improved output compared with conventional PWM techniques [5].

The steady-state approach and its transient conditions of SVM controller modify the MC controller parameters in order to improve performance. The shaft of the IG is controlled by the MC to extract more power for different wind velocities which rotates the WT [15].

A combination of WT and an SCIG is interfaced to grid with the help of a MC. The mechanical generated power developed from the WT is a part of shaft speed. For a specified wind speed, to acquire maximum power available from the WT shaft speed of the IG has to be controlled with frequency change. To acquire maximum power for the different wind speeds the stator frequency of IG is controlled from the MC [14].

III. RESULTS AND DISCUSSION

The Simulink model for WECS involves WT, a gearbox, a SCIG, MC connected to grid as shown in Fig.7. It depicts the generation of grid active power particular changes in wind velocity. To maximize the power generation to the grid captured from the wind, the MPPT controlling method controls the shaft speed by regulating the MC output frequency. The controller adjusts the MC parameters to maintain power factor such a way to control the responsive (reactive) power transfer at interface with the grid. Fig 8 shows the waveform for maximum power extraction at UPF for 9m/s wind speed.

Wind velocity of 9 m/s will provide system having algorithm at stable point to extract maximum power point [6][9].

Fig.9 depicts the results of rotor speed of the generator measured in pu, torque applied(mechanical) in pu to the generator, Torque (electromagnetic) for wind speed 9m/s. Fig.10 shows the results obtained for Phasor voltages (phase to ground), Phasor currents, WTIG output reactive power [7][13].

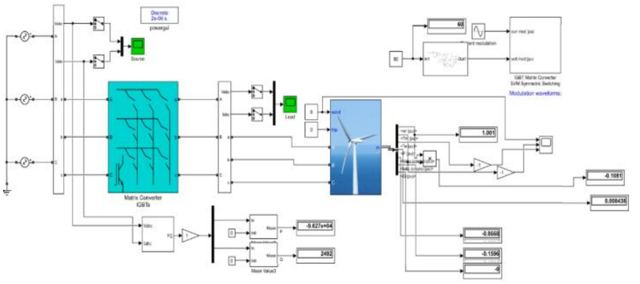

Fig 7: Simulation of Wind Energy conversation system connected to grid

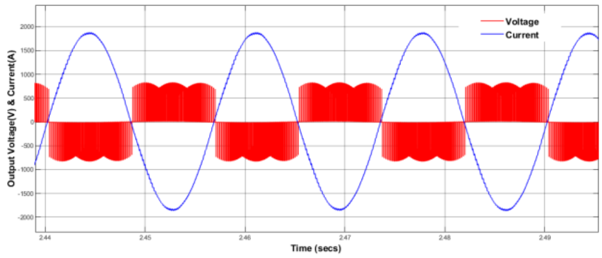

Fig 8: Waveform for maximum power extraction at UPF

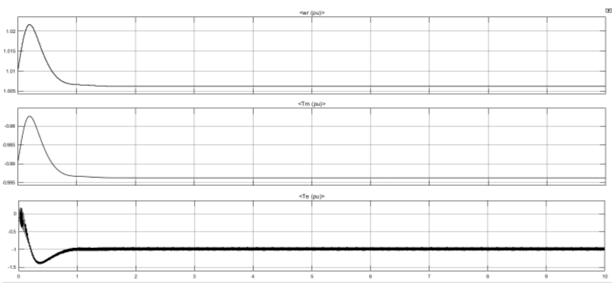

Fig.9 : Results obtained from wind speed 9m/s a)Generator rotor speed b) torque(Mechanical) applied to the generator c) Electromagnetic field due to time varying voltage(Torque)

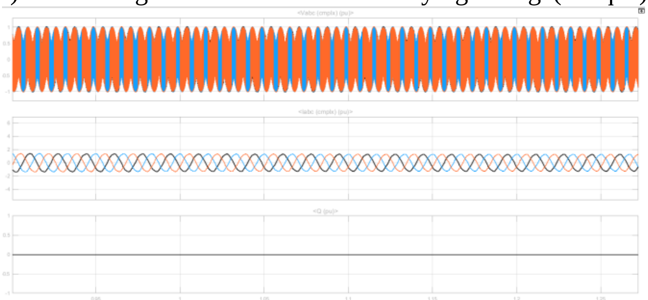

Fig.10: results obtained from wind speed 9m/s a) Phasor voltages (phase to ground) b) Phasor currents c) WTIG output reactive power

Fig. 11 demonstrates that for each power curve, correspondent to each constant wind speed, there is one idea where the power (mechanical) extracted from the wind which provides maximum energy. As the wind speed changes, the designed controllers for MC should assure that the WT and IG is kept on the maximum energy extraction curve to generate maximum energy from the wind.

. Two kinds of controller are used to follow the maximum energy extraction point: Speed control – control of the IG speed, bestowing to particular wind speed; method of controlling torque – control of torque (mechanical) delivered to the generator. In both controlling methods a reference value is established and the MC applies the space vectors necessary to follow this reference [8]. Pitch of the angle is kept zero so that we can extract maximum power (mechanical). However, it is important to mention that the pitch control is usually activated when the wind blows at higher speed that the minimal, in order to keep the minimal power of the generator [4].

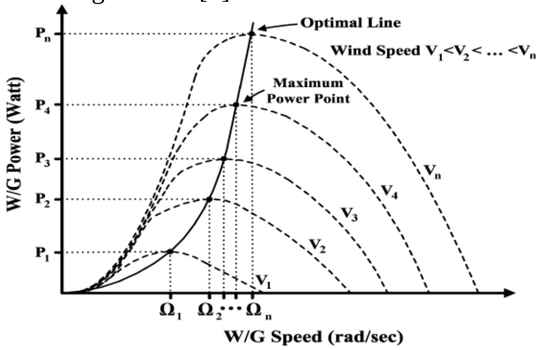

Fig. 11: Characteristic curve of the WT [1][19]

Power produced from the WT movement is at different wind speed is presented in Table 4.[19] The power generated for changing Stator frequency of IG is considered for specific wind speeds is calculated. Table 4 shows power developed for particular frequency and wind speed. The wind energy generated for 60Hz 8 m/s wind speed is 66.6%. For the same wind speed if the frequency of the Stator is reduced the power extraction is more from the induction machine. For instance, at 60hz and when wind speed has a value of 8m/s the power extracted from the IG is 66.6%, for 59Hz frequency and when wind speed is of the order 8m/s it is 67.62% in the same way maximum power is extracted at 57hz wind speed is 8m/s i.e., 69.03%. If we consider wind speed 7m/s and frequency of the Stator is 60Hz then the power developed will be 36.04%. If the frequency of a Stator is reduced to 55Hz then power developed will be 42.39%. The power developed at 60Hz is less than the power developed at 55Hz. Therefore, if Stator frequency is controlled for particular value then maximum power can be extracted.

The Table 5 indicates, there is increase in power generation with reference to particular wind speeds for different stator frequency. It is noted that as the wind speed changes power extraction is maximum compared to conventional methods used. If stator frequency is not changed with respect to change in wind speed then power extraction is less compared to this method [11 - 29].

Table 4: Frequency Vs Wind Speed and Power Generation.

Frequency(Hz) / Wind speed	9m/s	8m/s	7m/s
60	0.999	0.6669	0.3604
59	0.999	0.6762	0.370

58	0.9402	0.6842	0.389
57	0.915	0.6903	0.4019
56	0.903	0.644	0.4139
55	0.896	0.608	0.4239
54	0.8906	0.598	0.3951
53	0.8806	0.5908	0.3714
52	0.8720	0.5858	0.3592

Table5: Power increased with variable Frequency.

Wind speed	Maximum Power with constant frequency 60Hz	Maximum Power with variable Frequency	% Power Increased
9m/s	0.999	0.999	0%
8m/s	0.6669	0.6903(57Hz)	4.5%
7m/s	0.3604	0.4239(55Hz)	16.66%

IV. CONCLUSION

In this paper, a WECS using MC for grid connection is proposed. SCIG is connected to wind turbine because of its robustness, low cost and reliability. WT rotates the shaft with the help of gear box in accordance with the wind speed. The SCIG and grid are interfaced by the MC so that the complete power generated by the WT and IG is shifts to grid. Constant v/f approach based on the MC controls the terminal end voltage, frequency of the IG to control the rotation of turbine shaft speed accordingly. The power (active) generated is transferred to the grid and extracting the extreme power with diverse wind velocities. Power factor controlled by MC so that maximum power (active) is injected to the grid. The power generation rises for different wind speed if IG stator frequency is controlled. The controller with SVM method controls rotation of the shaft (IG) speed to maximize the power extraction from the wind. This is feasible by regulating the MC output frequency according to the constant V/f approach. The controller also adjusts the MC variables to control the reactive power transfer at the grid interface to regulate the power factor. The proposed technique provides the minutiae of maximum power extraction from wind so that it is helpful to the society. Hence, the results of this approach reveal the admirable performance of this system. Matlab /Simulink environment is used for simulating all the methods of operation.

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REFERENCES

1. Hyong Kim, Dylan Dah-Chuan Lu "Wind Energy Conversion System Electrical Perspective —A Survey" Smart Grid and Renewable Energy source Vol.1 No.3 , Article ID:3324,2010
2. Barakati S, Kazerani M, X Chen, "A new wind turbine generation system based on matrix converter" in Proc. IEEE PES Gen. Meet., ,pp: 2083–2089. 2005
3. Wheeler P.W, Rodriguez, J. Clare,. Empringham L, and. Weinstein A, 2002 "Matrix converters: A technology review," IEEE Trans. Ind. Elctron., vol. 49, no. 2, pp. 276–289, Apr.
4. E. Koutroulis and Kalaitzakis K, "Design of a maximum power tracking system for wind-energy-conversion applications," IEEE Trans. Ind.Electron., vol. 53, no. 2, pp. 486–494,2006.
5. S. M. Barakati, J. D. Aplevich, and M. Kazerani, "Controller design for a wind turbine system including a matrix converter," in Proc. IEEE PES Gen. Meet., 2007, pp. 1–8.
6. S. M. Barakati, "Modeling and controller design of wind energy conversion system including a matrix converter," Ph.D. dissertation, Dept. Electrical and Computer Engineering Univ. Waterloo, Waterloo, ON, Canada, 2008.
7. S Vaishali and A Jamna Design And Simulation of Matrix Converter for Wind Mill Applications Int. Journal. of Advanced Trends in Computer Science and Engineering vol 2 No.2 p 181-186 (2013).
8. Vinod K, Rahul Choudhary, Bherudas V. and Prashant U. "Performance Investigation of Matrix Converter Interfaced Wind Energy Conversion System" Int. Jou. of Computer Science and Electronics Engineering (IJCSEE) Vol. 2, Issue 2 ISSN 2320–4028. (2014)
9. N. R. Bhasme, Dr. W. Z. Gandhare "Power Converters for Grid Integration of Wind Power Systems" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue4, July-August 2012, pp.2181-2185.
10. Pandu Ranga Reddy and M. Vijaya Kumar "Implementation of Matrix Converter based PMSG for Wind Energy Conversion System" Proceedings of 7th Int. conf. on Intelligent Systems and Control (ISCO 2013).
11. L Empringham, J W Kolar,J Rodriguez, P Wheeler,J C Clare"Technological Issues and Industrial Application of matrix converters" IEEE Transactions on Ind.elect., Vol.60 No.10,PP 4260-4271,October 2013.
12. Johann K, "Novel Three-phase AC–AC Matrix Converters" IEEE transact. on power electronics, vol. 22, no. 5, Sept. 2007
13. Deepanshi R, Sudhanshu T" Modelling & Performance Analysis of Wind Energy with Matrix Converter International Journal of Science, Engg. and Tech. Research (IJSETR), Vol. 4, Issue 5, May 2015
14. Pattathurani R Kumar Dwibedi, Dr. Dash S. "Matrix Converter Technology for Wind Energy Conversion Systems" International Journal for Research in Applied Science & Engg. Tech.(IJRASET) Vol. 4 ,Oct. 2016
15. Thiyaagarajan, S Ramkumar, A. Amudha, G. Emayavaramban, M. Sivaram Krishnan, D. Kavitha "SVPWM based Control of SCIG-Matrix Converter for Wind Energy Power Conversion System" International Journal of Recent Technology and Engineering (IJRTE) June 2019, ISSN: 2277-3878, Volume no.8, Issue no.1S4.
16. Krishnan G, M. Siva Ramkumar, Amudha, G. Emayavaramban, S.Divyapriya, M. Sivaram Krishnan "Control of A Doubly Fed Induction Generator for Wind Energy Conversion System Using Matrix Converter with SVPWM Technique" International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Vol. 8, Issue 1S4, Jun. 2019.
17. Huber, L. and Borojevic, "Space Vector Modulated Three-Phase to Three-Phase Matrix Converter with Input power Factor Correction", IEEE Transactions on Industry Applications, Vol. 31, No. 6, November/December 1995.
18. Prasad, V., 'Analysis and Comparison of Space Vector Modulation Schemes For Three-Leg and Four-leg Voltage Source Inverters', Master Thesis, Electrical Engineering, Virginia Tech, May 15, 1997.
19. Masoud Barakati, Mehrdad K, J. D Aplevich, maximum Power Tracking Control for a Wind Turbine System Including a Matrix Converter IEEE transactions on energy conversion systems, vol. 24, no. 3, sept. 2009.
20. Siegfried H, "Grid Integration of Wind Energy Conversion Systems," John Wiley & Sons Ltd, 1998.
21. Rajendran T et al, "Recent Innovations in Soft Computing Applications", Current Signal Transduction Therapy, Vol. 14, No. 2, pp.129 – 130, 2019.

22. Emayavaramban G et al, "Indentifying User Suitability in sEMG based Hand Prosthesis for using Neural Networks", Current Signal Transduction Therapy, Vol. 14, No. 2, pp. 158 – 164, 2019.
23. Rajendran T & Sridhar K P, "Epileptic seizure classification using feed forward neural network based on parametric features". International Journal of Pharmaceutical Research, 10(4): 189-196, 2018.
24. Hariraj V et al, "Fuzzy multi-layer SVM classification of breast cancer mammogram images", International Journal of Mechanical Engineering and Technology, Vol. 9, No.8, pp. 1281-1299, 2018.
25. Muthu F et al, "Design of CMOS 8-bit parallel adder energy efficient structure using SR-CPL logic style", Pakistan Journal of Biotechnology, Vol. 14, No. Special Issue II, pp. 257-260, 2017.
26. Yuvaraj P et al, "Design of 4-bit multiplexer using Sub-Threshold Adiabatic Logic (STAL)", Pakistan Journal of Biotechnology, Vol. 14, No. Special Issue II, pp. 261-264, 2017.
27. Keerthivasan S et al, "Design of low intricate 10-bit current steering digital to analog converter circuitry using full swing GDI", Pakistan Journal of Biotechnology, Vol. 14, No. Special Issue II, pp. 204-208, 2017.
28. Vijayakumar P et al, "Efficient implementation of decoder using modified soft decoding algorithm in Golay (24, 12) code", Pakistan Journal of Biotechnology, Vol. 14, No. Special Issue II, pp. 200-203, 2017.
29. Rajendran T & Sridhar K P, "Epileptic Seizure-Classification using Probabilistic Neural Network based on Parametric Features", Journal of International Pharmaceutical Research, Vol. 46, No.1, pp. 209-216, 2019.

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