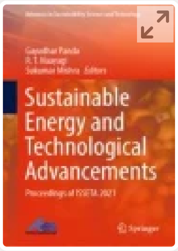


Conference proceedings | © 2022

Sustainable Energy and Technological Advancements

Proceedings of ISSETA 2021

Editors: Gayadhar Panda, R. T. Naayagi, Sukumar Mishra

Presents research works in the field of sustainable energy and technological advancements

Provides the results of ISSETA 2021 held in NIT Meghalaya, Shillong, India

Serves as a reference for researchers and practitioners in academia and industry

Part of the book series: Advances in Sustainability Science and Technology (ASST)

Sections

About the editors
Bibliographic Information

Table of contents (64 papers)

Search within book

Previous Page 1 of 4 Next

About this book

This book contains selected papers presented at the First International Symposium on Sustainable Energy and Technological Advancements (ISSETA 2021), which was organized by the Department of Electrical Engineering, NIT Meghalaya, Shillong, India, during September 24–25, 2021. The topics covered in the book mainly focuses on the cutting-edge research domain with respect to sustainable energy technologies, smart building, integration, and application of multiple energy sources; advanced power converter topologies and their modulation techniques; and information and communication technologies for smart microgrids.

Back to top ↑

Keywords

Advanced Power Converters

Energy Management System

Microgrids

Modulation Techniques

Renewable Energy Sources

Smart Building

Sustainable Energy

Back to top ↑

Editors and Affiliations

Department of Electrical Engineering, National Institute of Technology Meghalaya, Shillong, India

Gayadhar Panda

School of Electrical and Electronic Engineering, Newcastle University, Singapore, Singapore

R. T. Naayagi

Department of Electrical Engineering, Indian Institute of Technology Delhi, New Delhi, India
Sukumar Mishra

Back to top ↑

About the editors

Gayadhar Panda received the B.E. degree in electrical engineering from the Institute of Engineers, Kolkata, India, in 1996, the master's degree in power electronics from IIEST, Shibpur, India, in 1998, and the Ph.D. degree in electrical engineering from Utkal University, Bhubaneswar, India, in 2007. Since 2013, he has been with the Department of Electrical Engineering, National Institute of Technology at Meghalaya, Shillong, India, where he is currently a Professor. He served as the Head of the Department and the Chairman of various committees at the Institute level. He is currently looking after the Dean (FW), the Dean (AA), and a Chief Vigilance Officer (CVO) at NIT Meghalaya. He has published more than 80 technical articles in national and international conferences proceedings/journals. He has received the Institution Medal for obtaining the highest marks in graduation and the Power Medal for his one of the research article. He has more than 20 years of teaching experience. His current research interests include automatic generation control, stability improvements using flexible alternating current transmission system devices, power quality, power electronic converters, and distributed power generation.

R.T. Naayagi received the bachelor's degree (Hons.) in electrical and electronics engineering from Bharathidasan University, Tiruchirappalli, India, in 2000, the master's degree in information technology from Alagappa University, Karaikudi, India, in 2003, the master's degree (Hons.) in power electronics and drives from Anna University, Chennai, India, in 2005, and the Ph.D. degree in electrical and electronic engineering from The University of Manchester, Manchester, U.K., in 2010. She held various roles as a Lecturer/Senior Lecturer/Professor in various institutions in India and U.K, from 2000 to 2006 and from 2010 to 2014. She has been with The Newcastle University in Singapore (NUiS), since 2014, where she is currently an Associate Professor in electrical power engineering, and also the Director of excellence in learning and teaching. Her research interests include renewable energy integration and applications in smart grid, power electronics for aerospace, electric vehicle applications, low carbon electrical energy systems, and power electronic solutions to sustainability. Dr. Naayagi is a Steering Committee Member of NU Women, U.K., a member of the Diversity Working Group, Newcastle University, U.K., and Equality & Diversity Champion for NUiS, and an Academic Lead for Athena SWAN Bronze Award application at Newcastle University. She is a Senior Fellow of the Higher Education Academy, U.K. She has received several merit certificates for her academic proficiency, including the Best Outgoing Female Graduate Award during her bachelor's and the Outstanding Master's Student Award. She was a first recipient of the Dorothy Hodgkin Postgraduate Award from the School of Electrical and Electronic Engineering, University of Manchester, for her Ph.D., jointly sponsored by Rolls-Royce plc and the Engineering and Physical Sciences Research Council, U.K. She received the Woman Engineer Award from the Young Professionals Section Chennai, Institution of Engineering and Technology (IET), U.K., in 2012. She received the Newcastle University Teaching Award, in 2016. She is the Chair of NUiS women in science and engineering network and has been organizing many events to promote young professionals, especially young women in engineering and technology. She is the Chair of the IEEE Power and Energy Society, Singapore Chapter.

She is an Associate Editor of the IET Power Electronics Journal and an Associate Editor of the CSEE Journal of Power and Energy Systems. She serves as a Reviewer for the IEEE, IET, and many other international journals and conferences.

Sukumar Mishra received his M.Tech. and Ph.D. degrees in electrical engineering from the National Institute of Technology, Rourkela, in 1992 and 2000, respectively. After spending nine years as a lecturer at Sambalpur University (Orissa), Prof. Mishra joined BPUT (Orissa) as a Reader at the Electrical Department and served there for two years. Currently he is a Professor with the Indian Institute of Technology (IIT) Delhi and has been its part for the past 17 years, and has been functioning as Associate Dean R&D of IIT Delhi from March 2020. He has won many accolades throughout his academic tenure of 27 years. He has been a recipient of Young Scientist Award (1999), INSA Medal for Young Scientist (2002), INAE Young Engineer Award (2002), INAE Silver Jubilee Young Engineer Award (2012), The Samanta Chandra Shekhar Award (2016), Bimal Bose Award (2019) and NASI-Reliance Platinum Jubilee Award (2019). He has been selected as the Mission Innovation National Champion (2019) under the Mission innovation initiative to accelerate clean energy in India. He has been granted fellowships from many prestigious technical societies like IET (UK), NASI (India), INAE (India), IETE (India), and IE (India) and is also recognized as the INAE Industry-Academic Distinguish Professor. Apart from all research and academic collaborations, Prof. Mishra is very actively involved in industrial collaborations. He is currently an ABB Chair Professor and has previously delegated as the NTPC, INAE and Power Grid Chair Professor. He has also served as an Independent Director of the Cross Border Power Transmission Company Ltd., and the River Engineering Pvt. Ltd. Prof. Mishra has also carried out many important industrial consultations with TATA Power, Microtek and others. He has so far authored more than 80 IEEE

Transactions/Journals, 30 IET Journals and 30 other international journal papers. He has supervised 31 PhD students (16 on goings), 40 Master students (2 ongoing). Prof. Mishra has also authored five book chapters so far and has 13 patents to his credit. His research interests include power systems, power quality studies, renewable energy, and smart grid. Prof. Mishra has been working in close association with the IEEE Delhi Section Executive Committee for past few years and is currently serving as an Editor for the IEEE Transactions on Smart Grid, IEEE Transactions on Sustainable Energy and was an Area Editor for the IET Generation, Transmission and Distribution.

Bibliographic Information

Book Title
Sustainable Energy and Technological Advancements

Book Subtitle
Proceedings of ISSETA 2021

Editors
Gayadhar Panda, R. T. Naayagi, Sukumar Mishra

Series Title
Advances in Sustainability Science and Technology

DOI
https://doi.org/10.1007/978-981-16-9033-4

Publisher
Springer Singapore

eBook Packages
Energy, Energy (R0)

Hardcover ISBN
978-981-16-9032-7

eBook ISBN

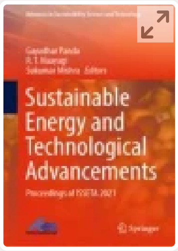
Series ISSN

Series E-ISSN

978-981-16-9033-4	2662-6829	2662-6837
Edition Number	**Number of Pages**	**Number of Illustrations**
1	XXVII, 859	152 b/w illustrations, 421 illustrations in colour

Topics
Electrical Power Engineering, Renewable Energy, Wind Energy, Solar Thermal Energy, Energy Grids and Networks, Sustainable Architecture/Green Buildings

Back to top ↑



Sustainable Energy and Technological Advancements pp 15–28

Modeling and Performance Evaluation of MPPT-Based PMSG Wind Energy Conversion System with Boost Converter in MATLAB/Simulink Environment

Snehashis Ghoshal, Sumit Banerjee & Chandan Kumar Chanda

Conference paper | First Online: 25 March 2022

Part of the Advances in Sustainability Science and Technology book series (ASST)

Abstract

In wind energy conversion system (WECS), the power from the blowing wind is converted to a suitable form. In most of the cases, this power is utilized to generate electricity, and in a few applications, windmill is installed for pumping purpose. In electricity installations, a dedicated wind turbine fitted with necessary accessories such as gear, generator, nacelle, brake system and yaw controller converts the kinetic energy of wind into electrical one. Mostly, AC generators are utilized in

WECS applications. In earlier days, asynchronous generators were in use. However, in the present scenario, synchronous machines, particularly permanent magnet synchronous generator (PMSG), are mostly used in wind energy applications. For small-scale applications, output of the WECS is converted to DC through suitable rectifier. However, due to the uncertainty in the wind flow, the power output in such a case scenario is unregulated one and cannot be applied to any load due to huge fluctuation. In this aspect, a power electronic converter is cascaded before the load and the power obtained from WECS is regulated and applied to the load. This application may find its usefulness particularly in coastal areas where abundant wind flow is available and can be efficiently utilized to run charging stations for electric vehicles (EVs). In the present study, a small-scale application of PMSG-based WECS is modeled in MATLAB/Simulink environment along with a DC load system. Output of the WECS is converter to DC through diode bridge rectifier, and then, the unregulated power is regulated by a boost converter. This converter is controlled by a maximum power point tracking (MPPT) controller which works on hill climbing algorithm so that maximum power can be extracted from such a system. The controller controls the duty ratio of the boost converter so that the system nearly extracts maximum power.

Keywords

Sustainability **Wind energy conversion system**

Permanent magnet synchronous generator

MPPT controller **DC–DC converter**

Hill climbing algorithm

Abbreviations

P_{tur} : Mechanical output of turbine, W

ρ : Air density, kg/m^3

A : Turbine swept area, m^2

C_{p} : Power coefficient

λ : Tip–speed ratio

β : Pitch angle, °

v_{w} : Velocity of wind, m/s

ω_{t} : Rotational speed of wind turbine, rad/s

r_{t} : Blade radius, m

c_1 : Characteristic constant = 0.5176

c_2 : Constant = 116

c_3 : Constant = 0.4

c_4 : Constant = 5

c_5 : Constant = 21

c_6 : Constant = 0.0068

V_{d}, V_{q} : $d-q$ stator voltage components, respectively, V

i_{d}, i_{q} : $d-q$ stator current components, respectively, A

R_{s} : Stator resistance

ω_{e} : Angular speed of rotor, rad/s

L_{d}, L_{q} : $d-q$ axis stator inductance, respectively, H

ψ_{d}, ψ_{q} : $d-q$ stator flux linkage, respectively

ψ_{pm} **:** Permanent magnet flux linkage

P **:** Number of pole pairs

References

1. Jash T (2007) Renewable energy and environment. Geogr Rev India 69:20–24

2. Gollagari R, Rena R (2013) An empirical analysis of energy consumption and economic growth in India: are they casually related? Studia Oecon 58(2):22–40

3. Stern DI, Cleveland CJ (2004) Energy and economic growth

4. Guo WW (2017) An analysis of energy consumption and economic growth of Cobb-Douglas production function based on ECM. In: ICAESEE 2017

5. Koltun P (2010) Materials and sustainable development. Progr Nat Sci Mater Int 20:16–29

6. Gambini M, Vellini M, Stilo T, Manno M, Bellocchi S (2019) High-efficiency cogeneration systems: the case of the paper industry in Italy. Energies

7. https://beeindia.gov.in/sites/default/files/2Ch7.p

df

8. Chaphekar SN, Khatavkar VV, Apte AA (2006) Cogeneration an emerging trend in India for energy crisis. In: 2006 IEEE international conference on industrial technology

9. Thakkar A, Chaudharia K, Shaha M (2020) A comprehensive survey on energy-efficient power management techniques. Procedia Comput Sci 167:1189–1199

10. https://beeindia.gov.in/sites/default/files/BEE%20Final%20Report_1.pdf

11. http://www.aeee.in/wp-content/uploads/2016/03/AEEE-EE-Book-Online-Version-.pdf

12. Simanaviciene Z, Volochovic A, Vilke R, Palekiene O, Simanavicius A (2015) Research review of energy savings changing people's behavior: a case of foreign country. Procedia Soc Behav Sci 191:1996–2001

13. Kamalapur GD, Yaragatti UR (2009) Electrical energy conservation in India—challenges and achievements. In: International conference on control, automation, communication and energy conservation

14. https://www.beeindia.gov.in/sites/default/files/Energy%20conservation%20guidelines%20for%20industries.pdf

15. Shrestha RM, Timilsina GR (1996) Factors affecting CO_2 intensities of power sector in Asia: a Divisia decomposition analysis. Energy Econ 18(4):283–293

16. https://www.oecd.org/greengrowth/greening-energy/49157219.pdf

17. Lekshmanan R (2015) Energy conservation—a case study. Int J Appl Eng Res 10

18. https://beeindia.gov.in/sites/default/files/1Ch3.pdf

19. Chen P, Yan B, Liu C, Wang S, Liu Y (2015) A comparative study on MPPT for photovoltaic generation systems. In: IEEE 2nd international future energy electronics conference (IFEEC), pp 1–6

20. Mohamed N, Shannan AA, Yahaya NZ, Singh B (2013) Single-diode model and two-diode model of PV modules: a comparison. In: Proceedings of ICCSCE, pp 210–214

21. Garg R, Singh A, Gupta S (2014) PV cell models and dynamic simulation of MPPT trackers in

MATLAB. In: Proceedings of INDIACOM, pp 6–12

22. Brito MAG, Galotto L Jr, Sampaio LP, Melo GA, Canesin CA (2013) Evaluation of the main MPPT techniques for photovoltaic applications. IEEE Trans Ind Electron 60(3):1156–1167

23. Li Y, Huang W, Huang H, Hewitt C, Chen Y, Fang G et al (2013) Evaluation of methods to extract parameters from current voltage characteristics of solar cells. Sol Energy 90:51–57

24. Maffezzoni P, Codecasa L, D'Amore D (2009) Modeling and simulation of a hybrid photovoltaic module equipped with a heat recovery system. IEEE Trans Ind Electron 56:4311–4318

25. Dondi D, Bertacchini A, Brunelli D, Larcher L (2008) Modeling and optimization of a solar energy harvester system for self-powered wireless sensor networks. IEEE Trans Ind Electron 55:2759–2766

26. Benavides ND, Chapman PL (2008) Modeling the effect of voltage ripple on the power output of photovoltaic modules. IEEE Trans Ind Electron 55:2638–2643

27. Krishan R, Sood YR, Kumar BU (2013) The simulation and design for analysis of photovoltaic system based on MATLAB. In: Proceedings of ICEETS, pp 647–671

Author information

Authors and Affiliations

Department of Electrical Engineering, Dr. B.C. Roy Engineering College, Durgapur, West Bengal, India

Snehashis Ghoshal & Sumit Banerjee

Department of Electrical Engineering, IIEST Shibpur, Howrah, India

Chandan Kumar Chanda

Editor information

Editors and Affiliations

Department of Electrical Engineering, National Institute of Technology Meghalaya, Shillong, India

Prof. Gayadhar Panda

School of Electrical and Electronic Engineering, Newcastle University, Singapore, Singapore

Dr. R. T. Naayagi

Department of Electrical Engineering, Indian Institute of Technology Delhi, New Delhi, India

Prof. Sukumar Mishra

Rights and permissions

Reprints and Permissions

Copyright information

About this paper

Cite this paper

Ghoshal, S., Banerjee, S., Chanda, C.K. (2022). Modeling and Performance Evaluation of MPPT-Based PMSG Wind Energy Conversion System with Boost Converter in MATLAB/Simulink Environment. In: Panda, G., Naayagi, R.T., Mishra, S. (eds) Sustainable Energy and Technological Advancements. Advances in Sustainability Science and Technology. Springer, Singapore. https://doi.org/10.1007/978-981-16-9033-4_2

.RIS .ENW .BIB

DOI

https://doi.org/10.1007/978-981-16-9033-4_2

Published	Publisher Name	Print ISBN
25 March 2022	Springer, Singapore	978-981-16-9032-7

Online ISBN	eBook Packages
978-981-16-9033-4	Energy Energy (R0)