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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

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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.

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Keywords

Advanced Power Converters

Energy Management System **Microgrids**

Modulation Techniques

Renewable Energy Sources

Smart Building **Sustainable Energy**

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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.

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Topics

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

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Planning of Power Loss and Fuel Cost Minimization by Deployment of DERs Using Evolutionary Algorithm

Deblina Maity, 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 this paper, optimal sizing, type, and placement of distributed energy resources have played very significant role for decrement of power loss and fuel cost in distribution network. Suitable sizing and location of distributed energy resources (DERs) are chosen by loss minimization using teacher–learner relationship algorithm and cost minimization using pollination process algorithm (FPA). With proper allocation of DERs, grid power loss is reduced. Economic load dispatch is optimal power allocation satisfying load demand where cost is minimized. Here micro-grid is combination of three diesel

generators (D_g) and two micro-turbines (M_t). The usefulness of the proposed idea has been experienced on a distribution network connected radically (12.66 kV) containing thirty-three nodes.

Keywords

Micro-grid **Distributed generator**

Flower pollination **Global pollination**

Micro-turbine

Abbreviations

$\mathrm{Po}_{\mathrm{loss}}$: Total real power loss in the system

$\mathrm{Qo}_{\mathrm{loss}}$: Total reactive power loss in the system

Po_{i+1} : Active power at $i+1$ node

Qo_{i+1} : Reactive power at $i+1$ node

Re_S : Resistance of the network

Xe_S : Reactance of the network

Vol : Voltage of particular node

$\mathrm{Vol}_{\min}$: Minimum limit of voltage

$\mathrm{Vol}_{\max}$: Maximum limit of voltage

$XX_i^{\min}$: Minimum level of operation region of particular generator

$XX_i^{\max}$: Maximum level of operation region of particular generator

C_i : Objective function economic load dispatch problem (XX_i)

XX_i : Electricity energy generated by generators

Mm: Number of existing operated generators

XX_D : System load driven by generators

XX_L : Losses in power plant

pp_i : Running cost of unit *i*.

qq_i : Semi fixed cost of unit *i*.

rr_i : Fixed cost of unit *i*.

dd_i, ee_i: Cost coefficients of particular unit due to valve point loading effect

$\mathrm{PP}_{\mathrm{DER}_{\min}}$: Min active power limit of DERs

$\mathrm{PP}_{\mathrm{DER}_{\max}}$: Max active power limit of DERs

$QQ_{\mathrm{DER}_{\min}}$: Min reactive power range of DERs in distribution network

$QQ_{\mathrm{DER}_{\max}}$: Max reactive power range of DERs in distribution network

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