Lecture Notes in Electrical Engineering 1086

Hasmat Malik · Sukumar Mishra ·
Y. R. Sood · Atif Iqbal ·
Taha Selim Ustun *Editors*

Renewable Power for Sustainable Growth

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Preface

The papers presented at the 2nd International Conference on Renewable Power (ICRP-2023) held at Mewat Engineering College (Wakf), India, on March 28–29, 2023, are anthologized in this book. The ICRP-2023 mainly focuses on advanced research in the area of renewable power, which includes 10 sub-themes such as: (1) Smart Grid Technologies and Applications; (2) Renewable Power Systems including Solar PV, Solar Thermal, and Wind; (3) Power Generation, Transmission, and Distribution; (4) Transportation Electrification and Automotive Technologies; (5) Power Electronics and Applications in Renewable Power System; (6) Energy Management and Control System; (7) Energy Storage in Modern Power System; (8) Active Distribution Network; (9) Artificial Intelligence in Renewable Power Systems; and 10) Cyber-Physical Systems and Internet of Things in Smart Grid and Renewable Power. This conference provides a platform for sharing insights, experiences, and interaction on various facts of evolving technologies. The ICRP-2023 also provides a platform for leading academic scientists, researchers, scholars, and students to get together to share their research discovery and ideas. A total of 269 participants have participated in hybrid mode, out of them 33% of authors are from overseas and made technical presentations. More than **240** articles were submitted, out of which **68** were accepted. About 40% of articles are from overseas in the list of accepted articles, and these articles are from the following countries: Malaysia, Spain, Thailand, Indonesia, Brunei, Saudi Arabia, Qatar, Singapore, Japan, Nigeria, South Korea, and Italy.

We sincerely appreciate everyone who contributed to this book and helped create top-notch research material. We really appreciate the reviewers' prompt delivery of the reviews, comments, and recommendations.

We would like to express our sincere gratitude to Haryana Renewable Energy Development Agency (HAREDA) for providing financial support to make ICRP-2023 successful.

We would like to express our sincere gratitude to Springer LNEE for providing publishing opportunity. We would like to extend our sincere gratitude to **Mewat Engineering College (Wakf)** (a unique venture of Haryana Waqf Board, Government of Haryana, in district Nuh, Mewat, India) for providing a venue to host ICRP-2023.

We express our sincere gratitude to our **Chief Patron** Ch. Zakir Hussain, Administrator, Haryana Waqf Board, Government of Haryana; **Patron** Dr. Hanif Qureshi, IPS, Director General, HAREDA; Sh. Mohammed Shayin, IAS, Chief Executive Officer, Haryana Waqf Board and Managing Director, HVPNL, Government of Haryana, India; and Prof. Sukumar Mishra, IIT Delhi, India; **Conference General Chair** Prof. (Dr.) Khwaja M. Rafi, Director, Mewat Engineering College (Wakf); **Conference General Co-chair** Prof. Y. R. Sood, VC, JP University, Noida; Prof. Atif Iqbal, Professor, Qatar University, Qatar; Prof. Fausto Pedro Garcia Marquez, Universidad Castilla-La Mancha, Spain; and Prof. Nik Rumzi, Professor, UTM Malaysia, Malaysia; **Conveners** Dr. Shaheen Khan, HOD—ECED, MECW; Dr. Tazeem Ahmad Khan, HOD—EEED, MECW; and Dr. Hasmat Malik, UTM, Malaysia; **Organizing Secretaries** Dr. Mohd. Junaid Khan, Assistant Professor, EEED, MECW; Mr. Adil Zaidi, Assistant Professor, ECED, MECW; and Dr. Shafqat Nabi Mughal, HOD, Department EE, SoET BGSB University, Rajouri (J&K); **Finance Chair/Treasurer** Dr. Shamshad Ali, Assistant Professor, EEED, MECW; Dr. Nuzhat Fatema, UniSZA Malaysia; **Steering Committee** Prof. Moinuddin, Ex-Director, NIT Jalandhar; Prof. S. K. Chakarvarti, AICTE, Margadarshak and Ex-Dean Academic, Delhi; and Mr. K. K. Chakarvarti, Former Energy Economist, BEE, Ministry of Power, GoI; **Organizing Committee** Dr. Mohd. Shahid, MECW; Mr. Naseem Ahmed, MECW; Mr. Mohd Umar Khan, MECW; and Ms. Shahina Bano, MECW; **Publication Committee** Prof. Surender Reddy Salkuti, Woosong University, South Korea; Dr. Shimi, SL, EED, NITTTR Chandigarh, India; Dr. Ikhlaq Hussain, NIT Srinagar; and Publicity Committee Dr. Shadab Murshid, Rolls-Royce Corporate Lab, NTU Singapore; Dr. Samir Kumar, Korea University, the Republic of Korea; Mr. Waseem Akram, MECW; Mr. Ayaz Mahmood, AO, HWB, Government of Haryana, India; Dr. Azaz Khan, MECW; and Dr. Ahmed Riyaz, BGSB University, India.

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We sincerely acknowledge all the keynote speakers for disseminating their knowledge, experience, and thoughts. We express our sincere gratitude to the management of **Mewat Engineering College (Wakf)**, Conference Executive Chair, **International Advisory Committee, National Advisory Committee, and Technical Program Committee members** for their kind support and motivation.

We wish to thank our colleagues and friends for their insight and helpful discussion during the production of this book. We would like to highlight the contribution, suggestion, and motivation of Prof. Imtiaz Ashraf, Aligarh Muslim University, India; Prof. M. S. Jamil Asghar, Aligarh Muslim University, India; Prof. Salman Hameed, Aligarh Muslim University, India; Prof. A. H. Bhat, NIT Srinagar, India; Prof. Kouzou Abdellah, Djelfa University, Algeria; Prof. Jaroslaw Guzinski, Gdansk University of Technology; Prof. Mairaj Ud Din Mufti, NIT Srinagar, India; Prof. Majid Jamil, JMI, India; Prof. Majed A. Altotaibi, King Saud University, Saudi

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Dr. Sukumar Mishra (Senior Member, IEEE) received his M.Tech. and Ph.D. in Electrical Engineering from National Institute of Technology, Rourkela in 1992 and 2000 respectively. Presently, Dr. Mishra is a Professor at the Indian Institute of Technology Delhi and has been its part for the past 19 years. Professor Mishra has won many accolades such as Young Scientist award (1999) by Orissa Bigyan Academy, 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), National Mission Innovation Championship award (2019) and INAE Outstanding Teachers award (2021). He has been granted fellowship from academies like NASI (India), INAE (India) and professional societies like IET (UK), IETE (India), IE (India). He has also been recognized as the INAE Industry Academic Distinguish

Professor. Professor Mishra is currently acting as ABB Chair professor and has previously delegated as the NTPC, INAE and Power Grid Chair professor.

Dr. Y. R. Sood (Senior Member, IEEE) has taken over as Vice-Chancellor with effect from 14 June 2021. Dr. Sood has an outstanding administrative, academic, research experience of more than 36 years. He obtained his B.Sc. degree from Government college for Men Chandigarh (Punjab University Chandigarh) in 1980, B.E. (Honours) Electrical Engineering in 1984 and M.E. Electrical Power System in 1987 from Punjab Engineering College Chandigarh, and Ph.D. from I.I.T. Roorkee in 2003. He has been a lecturer at Electrical Engineering Department of TIET Patiala from 6th January 1986 to 31st July 1986, at Electrical Engineering Department of N.I.T Kurukshetra (Haryana) from 1st August 1986 to 28th August 1991, Assistant Professor (equivalent to Associate Professor) at Electrical Engineering Department NIT Hamirpur (H.P.) from 29th August 1991 to 18th May 2003, Professor from 19th May 2003 to 27th April 2017 and Professor (HAG) w.e.f. 28th April 2017 to 13th June 2021. He has worked as Director, Chairman Board of Governors (BOG) at NIT Puducherry. He has worked as Dean (Research and Consultancy), Dean (Planning and Development), Dean (Faculty welfare) and Dean (Industrial Research Development and Consultancy), Head of Electrical Engineering Department, Member of BOG, Member of Senate, Coordinator/Chief Coordinator/Professor In-charge of TIFAC-CORE, Chief Vigilance Officer, Chairman Admission Committee, etc. at NIT Hamirpur and member of Senate, at NIT Calicut (Kerala). He has delivered more than 90 key notes/expert lectures in various international conferences, workshops, short term courses, etc., in India and abroad. He is the editor of three international books (two Springer Publisher and one Elsevier Publisher), many conference proceedings and technical reports. He has worked as Chairman/member of selection/interview boards for the various teaching and technical posts. He has organized and participated many short-term training programmes/short term courses and conferences. He has developed completely High Voltage Engineering Lab. from its very start and set up new experiments in various labs. He has successfully completed three MHRD research projects and one mega projects under TIFAC-CORE of Rs. 530 Lakhs. Twelve research scholars have already completed Ph.D. under his guidance. Two more research scholars are pursuing their Ph.D. under his guidance. He has Published more than 370 research papers in International and National Journals including several papers in SCI Journals, IEEE Transactions and conferences and many chapters in various international books.

Dr. Atif Iqbal (Senior Member, IEEE, Fellow IET, Fellow IE) received the B.Sc. and M.Sc. degrees in engineering (power system and drives) from Aligarh Muslim University (AMU), Aligarh, India, in 1991 and 1996, respectively, and Ph.D. degree from Liverpool John Moores University, Liverpool, UK, in 2006, and the D.Sc. degree (Habilitation) in control, informatics, and electrical engineering from the Gdansk University of Technology, in 2019. He is a Full Professor with the Department of Electrical Engineering, Qatar University, Doha, Qatar, and a former Full Professor with the Department of Electrical Engineering, AMU, Aligarh, India. He

has been a Lecturer with the Department of Electrical Engineering, AMU, since 1991, where he has served as a Full Professor, until August 2016. Dr. Iqbal has been listed in top 2% highly cited scientists of the world (data released by Stanford University, USA). The world ranking in 2019 was #649 and the current ranking is #622. He has published widely in international journals and conferences on his research findings related to power electronics, variable speed drives, and renewable energy sources. He has authored or co-authored more than 520 research articles and four books and several chapters in edited books. He has supervised several large research and development projects worth more than multi million USD. He was a recipient of the Maulana Tufail Ahmad Gold Medal for standing first at the B.Sc. Engg. (Electrical) Exams from AMU, in 1991. He was also a recipient of the Outstanding Faculty Merit Award academic year 2014–2015 and the Research Excellence Awards at Qatar University, in 2015 and 2019. He has received several best research papers awards, e.g., at IEEE ICIT-2013, IET-SEISCON-2013, SIGMA 2018, IEEE CENCON 2019, IEEE ICIOT 2020, ICSTEESD-20, Springer ICRP 2020, IEEE GUCON 2021. He has also received the Gold Medal for his B.Sc. degree. He is the Vice-Chair of the IEEE Qatar Section. He is also an Associate Editor of the IEEE Transactions on Industrial Electronics and IEEE Access and the Editor-in-Chief of the *Journal of Electrical Engineering* (I'manager). He was a former Associate Editor of the IEEE Transactions on Industry Application and a former Guest Associate Editor IEEE Transactions on Power Electronics. He is head of the design team of Power Electronics and Drives equipment at Powerlab Instruments, Chennai, India His research interests include smart grid, complex energy transition, active distribution network, electric vehicles drivetrain, sustainable development and energy security, distributed energy generation, and multiphase motor drive systems.

Dr. Taha Selim Ustun (Senior Member, IEEE) received his Ph.D. degree in electrical engineering from Victoria University, Melbourne, VIC, Australia. Currently, he is a senior researcher at Fukushima Renewable Energy Institute, AIST (FREA) and leads Smart Grid Cybersecurity Lab. Prior to that he was an Assistant Professor of Electrical Engineering with the School of Electrical and Computer Engineering, Carnegie Mellon University, Pittsburgh, PA, USA. His research interests include power systems protection, communication in power networks, distributed generation, microgrids, electric vehicle integration and cybersecurity in smart grids. He is a member of IEEE 2004, IEEE 2800 Working Groups and IEC Renewable Energy Management Working Group 8. He has edited several books and special issues with international publishing houses. He is a reviewer in reputable journals and has taken active roles in organizing international conferences and chairing sessions. He has been invited to run specialist courses in Africa, India and China. He delivered talks for Qatar Foundation, World Energy Council, Waterloo Global Science Initiative and European Union Energy Initiative (EUEI).

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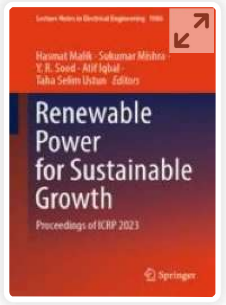

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Comparative Study on Solar PV Module Performance with Sun Irradiance Trapping Mechanism: Power Generation Forecasting Using Machine Learning

Rupendra Kumar Pachauri, Ashutosh Shukla, Ahmad Faiz Minai, Aryadhara Pradhan, Vinay Gupta, Mohit Kumar & Shashikant

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