Characterizing Renewable Electricity Supply in Transitioning Electricity Systems

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Abstract

Globally, electricity systems are transitioning from marginal to dominant renewable energy systems in terms of installed capacity and electricity generation shares. This transition has led to the situation of matching dynamic supply with dynamic demand. For effective management, electricity system planners and operators must have a clear understanding of the dynamics of the supply sources. Knowing these would enable them to identify periods of constrained supply and manage resources optimally. Studying 365 supply profiles for a year is a cumbersome exercise and it is impossible to observe the supply peculiarities from such a huge volume of data. Therefore, there needs to be a mechanism in place to capture these patterns along with magnitude, span, temporal effects and influential factors of supply-side variabilities. In this research, we propose a methodology for characterizing variations in supply profiles of solar and wind energy technologies by deploying a simulation-based approach. First, a logical clustering method is employed to form a smaller groups of supply profiles. Next, probability distribution-based Monte Carlo simulation is adopted to refine these groups of supply curves and arrive at a representative supply curve, which is called Representative Supply Profile (RSP). This approach is validated using data from Karnataka (a state in India) electricity system, and technology specific RSPs are developed. With this, we could represent the 365 days' hourly generation into 10 RSPs for solar and 14 RSPs for wind. The results show that solar and wind supply profiles represent different seasonal cycles.

Keywords
Electricity System Planning, Electricity Transition, Representative Supply Profiles, Electricity Modelling, Renewable Energy

Biographies

Varun Jyothiprakash is currently a Research Scholar in the Department of Management Studies at Indian Institute of Science, Bengaluru, India pursuing his research in Sustainable Transitions of Electricity Systems in India'. He has a bachelor's degree (B.E.) in Mechanical Engineering from Visvesvaraya Technological University, India. Subsequently, he has pursued MTECH in energy engineering from Jain University, Bengaluru, India. He has total four years of work experience as a sustainable consultant across organizations in India. His core competencies lie in the energy sector, low carbon growth, and energy policy studies

Dr. Balachandra Patil is a PhD from Indian Institute of Science, is an energy, environment, and sustainability expert, and ranked among top 10 management researchers in India (First in Strategic Management area). He is also ranked among top 2% of the Energy Scientists in the World. He has 35 years of experience as a faculty at the Indian Institute of Science, and as a visiting expert at Harvard University-USA, UNDP-Bangkok, AIT-Bangkok. and IGIDR-Mumbai. His research expertise includes energy & environmental economics and policy, sustainability transition, sustainable energy access, and energy system planning and modelling. He has investigated about 48 research & consultancy assignments for UNDP, European Commission, World Bank, SIDA, SANEI, RCUK, AIT, TERI, IGIDR, DST, and various ministries of government of India and private sector organizations. Has co-authored six books and published about 150 papers in International and National journals, conferences, and edited books with an H-Index of 26. He has supervised 37 PhD scholars (20 awarded and 17 ongoing). Has been conferred with the distinguished alumni award of Manipal University in 2011.