Solar Energy Forecasting And Resource Assessment 1st Edition

Solar radiation data is important for a wide range of applications, e.g. in engineering, agriculture, health sector, and in many fields of the natural sciences. A few examples showing the diversity of applications may include: architecture and building design, e.g. air conditioning and cooling systems; solar heating system design and use; solar power generation; evaporation and irrigation; calculation of water requirements for crops; monitoring plant growth and disease control; skin cancer research.

This book represents the combined peer-reviewed proceedings of the Eight International Symposium on Intelligent Distributed Computing - IDC'2014, of the Workshop on Cyber Security and Resilience of Large-Scale Systems - WSRL-2014, and of the Sixth International Workshop on Multi-Agent Systems Technology and Semantics- MASTS-2014. All the events were held in Madrid, Spain, during September 3-5, 2014. The 47 contributions published in this book address several topics related to theory and applications of the intelligent distributed computing and multi-agent systems, including: agent-based data processing, ambient intelligence, collaborative systems, cryptography and security, distributed algorithms, grid and cloud computing, information extraction, knowledge management, big data and ontologies, social networks, swarm intelligence or videogames amongst others.

This book presents methods for optimising the spatial and network configuration of solar radiation measuring stations. Various physical and mathematical models are demonstrated, which together with high quality measurements, provide the essential tools to generate and validate solar resource estimates to improve the mapping of solar resources. Each chapter deals with a specific topic, showing its methodology, and providing examples of how to apply these techniques with reference to current projects around the world. These topics include: · Radiometric measurement campaigns;· Equipment calibration, installation, operation, and maintenance;· Data quality assurance and assessment;· Solar radiation modelling from satellite images and numerical models;· Downscaling and kriging interpolation of solar radiation;· Simulation of electric solar power plant generation;· Solar radiation forecasting;· Applications of solar energy; and· Socio-economic benefits of solar energy. The contributors present the statistical and physical models needed to derive solar radiation from satellite images and numerical models, emphasising the importance of measuring solar radiation accurately. They also show the classical models used to generate synthetic data, clear sky models and ancillary air quality and meteorological data from different input sources. Solar Resources Mapping provides industry professionals with methodologies and tools to build solar irradiance maps for different applications. The book will also benefit students and researchers as it serves as a main technical reference, presenting the basic terminology and fundamentals for solar resource mapping that include methods for assessing measurement uncertainty.

Written by a leading scientist with over 35 years of experience working at the National Renewable Energy Laboratory (NREL), Solar Radiation: Practical Modeling for Renewable Energy Applications brings together the most widely used, easily implemented concepts and models for estimating broadband and spectral solar radiation data. The author addresses various technical and practical questions about the accuracy of solar radiation measurements and modeling. While the focus is on engineering models and results, the book does review the fundamentals of solar radiation modeling and solar radiation measurements. It also examines the accuracy of solar radiation modeling and measurements. The majority of the book describes the most popular simple models for estimating broadband and spectral solar resources available to flat plate, concentrating, photovoltaic, solar thermal, and daylighting engineering designs. Sufficient detail is provided for readers to implement the models in assorted development environments. Covering the nuts and bolts of practical solar radiation modeling applications, this book helps readers translate solar radiation data into viable, real-world renewable energy applications. It answers many how-to questions relating to solar energy conversion systems, solar daylighting, energy efficiency of buildings, and other solar radiation applications.

Analysis, Measurement and Assessment

Solar Resource Assessment with Sky Imagery and a Virtual Testbed for Sky Imager Solar Forecasting

3rd Indo-German Conference on Sustainability in Engineering

Edited by Fouzi Harrou and Ying Sun

Hearing Before the Subcommittee on Energy and Environment, Committee on Science and Technology, House of Representatives, One Hundred Eleventh Congress, Second Session, June 16, 2010

Satellites and Forecasting of Solar Radiation

Renewable Energy Forecasting: From Models to Applications provides an overview of the state-of-the-art of renewable energy forecasting technology and its applications. After an introduction to the principles of meteorology and renewable energy generation, groups of chapters address forecasting models, very short-term forecasting, forecasting of extremes, and longer term forecasting. The final part of the book focuses on important applications of forecasting for power system management and in energy markets. Due to shrinking fossil fuel reserves and concerns about climate change, renewable energy holds an increasing share of the energy mix. Solar, wind, wave, and hydro energy are dependent on highly variable weather conditions, so their increased penetration will lead to strong fluctuations in the power injected into the electricity grid, which needs to be managed. Reliable, high quality forecasts of renewable power generation are therefore essential for the smooth integration of large amounts of solar, wind, wave, and hydropower into the grid as well as for the

profitability and effectiveness of such renewable energy projects. Offers comprehensive coverage of wind, solar, wave, and hydropower forecasting in one convenient volume Addresses a topic that is growing in importance, given the increasing penetration of renewable energy in many countries Reviews state-of-the-science techniques for renewable energy forecasting Contains chapters on operational applications

"A significant barrier to the widespread adoption of many forms of renewable energy, including wind, solar, and marine and hydrokinetic power, is that these sources are intermittent. Electric grid managers address this intermittency by adjusting the delivery of other sources of power based on expected changes in renewable power output. These expected changes are called power production forecasts. Such forecasts must take into account changing weather conditions in conjunction with the land's topography near a renewable energy device, along with the device's expected technical performance ... Several recent reports have determined that improving the accuracy and frequency of these forecasts can have a major impact on the economic viability of renewable energy resources" ... This hearing provides "testimony on the roles that various Federal agencies as well as the private sector play in providing forecasting data and services relevant to expanding the availability of reliable, renewable power, and the extent to which these efforts are coordinated. The hearing will also explore any research, development, demonstration, and monitoring needs that are not currently being adequately addressed."--P. 3-4.

This leading-edge volume on advances in photovoltaic technology features diverse contributions from experts in every major geographic PV market. It examines emerging applications such as electricity grid load-balancing and demand- response, PV storage systems, photovoltaic/thermal solar collectors and carbon-offset in buildings. Engineers, researchers, developers and students alike will find new avenues for exploration and fresh insights into this continually evolving field. Highlights the most recent advances in Photovoltaics, from Next-Gen Storage Systems to Bifacial PV/T Solar Collectors; Provides expert insights on the recent evolution and near future of PV markets around the globe; Covers applications from grid-tied storage and power generation to green buildings.

Solar and wind energy have the potential to power the world's energy needs. However, the variable and uncertain power generation from these sources are posing a major challenge for the reliable and economic integration in the existing electric power system. For solar energy, the problem consists of two related parts, (1) variability in the resource (determined by the location of a solar plant) and (2) uncertainty in power output, (determined by the local meteorological conditions). First, this work presents a verification of the accuracy of satellite image based irradiance models, used to globally assess the solar resource. The focus is placed on the direct normal irradiance (DNI) component of solar radiation and its variability. Second, we develop two solar forecasting methods, necessary for grid integration and market participation of solar energy generators. For intra-day forecasting, a satellite imagery based global horizontal irradiance (GHI) forecast methodology is proposed. For day-ahead forecasting, we present a numerical weather prediction (NWP) based model to predict hourly values of DNI, necessary for power output scheduling of concentrated solar power (CSP) plants. The proposed day-ahead forecast is extensively validated for regions in North America with high and medium potential for the deployment of CSP. The benefits of this forecast for large scale grid integration of CSP plants, combined with optimized siting to reduce variability and uncertainty, are shown. Results include the quantification of errors in satellite based DNI assessment, the successful application of cloud tracking in satellite images for forecasts up to 3h ahead and the significant reduction of power output uncertainty for day-ahead market participation of CSP plants.

Solar and Infrared Radiation Measurements, Second Edition
Modeling Solar Radiation at the Earth's Surface
Time Series and Renewable Energy Forecasting, Chapter 6
Renewable Energy Forecasting
Solar Energy Resourcing and Forecasting for Optimized Grid Integration
The Performance of Concentrated Solar Power (CSP) Systems

This book provides an insight into how a country contributes to the GHG emissions reductions required to keep global warming within the limits set by the Paris Agreement arrived at COP21 in 2015. It shows what actions are needed for the implementation plan that Fiji will use to satisfy its quota (i.e. its Nationally Determined Contribution or NDC) of the total GHG emissions reductions. It is a primary resource material for those who wish to obtain an understanding of the science behind climate change mitigation. It reveals the behind-the-scenes action that takes place to convert the rhetoric of climate change into the action on the ground that actually reduces the GHG emissions and global warming. The book also presents a critique of methods adopted by nations in meeting their NDCs to emissions reductions as agreed at the Paris Agreement, and suggests improvements.

In recent years, ground-based sky imagers have emerged as a promising tool for forecasting solar energy on short time scales (0 to 30 minutes ahead). Following the development of sky imager hardware and algorithms at UC San Diego, we present three new or improved algorithms for sky imager forecasting and forecast evaluation. First, we present an algorithm for measuring irradiance with a sky imager. Sky imager forecasts are often used in conjunction with other instruments for measuring irradiance, so this has the potential to decrease instrumentation costs and logistical complexity. In particular, the forecast algorithm itself often relies on knowledge of the current irradiance which can now be provided directly from the sky images. Irradiance measurements are accurate to within about 10%. Second, we demonstrate a virtual sky imager testbed that can be used for validating and enhancing the forecast algorithm. The testbed uses high-quality (but slow) simulations to produce virtual clouds and sky images. Because virtual cloud locations are known, much more advanced validation procedures are possible with the virtual testbed than with measured data. In this way, we are able to determine that camera geometry and non-uniform evolution of the cloud field are the two largest sources of forecast error. Finally, with the assistance of the virtual sky imager testbed, we develop improvements to the cloud advection model used for forecasting. The new advection schemes are 10-20% better at short time horizons.

This report summarizes the technical presentations, outlines the core research recommendations, and augments the information of the Solar Resources and Forecasting Workshop held June 20-22, 2011, in Golden, Colorado. The workshop brought together notable specialists in atmospheric science, solar resource assessment, solar energy conversion, and various stakeholders from industry and academia to review recent developments and provide input for planning future research in solar resource characterization, including measurement, modeling, and forecasting.

This presentation provides a high-level overview of a fast radiative transfer model for solar resource assessment and forecasting.

Wind Field and Solar Radiation Characterization and Forecasting

Paris, France, June 7-9, 2017

Future of solar photovoltaic

Weather Modeling and Forecasting of PV Systems Operation

Research Advancements in Smart Technology, Optimization, and Renewable Energy

Electricity from Renewable Resources

A component in the America's Energy Future study, Electricity from Renewable Resources examines the technical potential for electric power generation with alternative sources such as wind, solar-photovoltaic, geothermal, solar-thermal, hydroelectric, and other renewable sources. The book focuses on those renewable sources that show the most promise for initial commercial deployment within 10 years and will lead to a substantial impact on the U.S. energy system. A quantitative characterization of technologies, this book lays out expectations of costs, performance, and impacts, as well as barriers and research and development needs. In addition to a principal focus on renewable energy technologies for power generation, the book addresses the challenges of incorporating such technologies into the power grid, as well as potential improvements in the national electricity grid that could enable better and more extensive utilization of wind, solar-thermal, solar photovoltaics, and other renewable technologies.

As an energy resource, solar energy provides a cleaner alternative to the conventional power generation systems and therefore solar energy has the potential to help achieve lower emissions standards as well to help provide domestic energy security. A major challenge, however, is the nondispatchability and variability of the solar resource which makes it necessary to develop forecasting methodologies in order to safely integrate with the electric grid. As dictated by current electricity markets, power generation is dispatched according to day-ahead unit commitment as well as 1-hour ahead and 15-minutes for load-following services. In order to integrate large penetration levels of solar energy into the current systems, forecasting at these time intervals are necessary. In this work, we develop and evaluate several solar irradiance forecast models for multiple-time horizons. The 1-day ahead forecasting models are based on forecasted elements from the National Weather System's (NWS) forecasting database (NDFD). The 1-hour ahead forecasting models are based on sky cover indices derived from ground measurements including solar and infrared radiometers as well as a sky imager and we also develop satellite-based models that utilize neural networks for time-series predictions. For very short-term forecasts of

Solar Energy Forecasting and Resource Assessment is a vital text for solar energy professionals, addressing a critical gap in the core literature of the field. As major barriers to solar energy implementation, such as materials cost and low conversion efficiency, continue to fall, issues of intermittency and reliability have come to the fore. Scrutiny from solar project developers and their financiers on the accuracy of long-term resource projections and grid operators' concerns about variable short-term power generation have made the field of solar forecasting and resource assessment pivotally important. This volume provides an authoritative voice on the topic, incorporating contributions from an internationally recognized group of top authors from both industry and academia, focused on providing information from underlying scientific fundamentals to practical applications and emphasizing the latest technological developments driving this discipline forward. The only reference dedicated to forecasting and assessing solar resources enables a complete understanding of the state of the art from the world's most renowned experts. Demonstrates how to derive reliable data on solar resource availability and variability at specific locations to support accurate prediction of solar plant performance and attendant financial analysis. Provides cutting-edge information on recent advances in solar forecasting through monitoring, satellite and ground remote sensing, and numerical weather prediction.

This book covers major technological advancements in, and evolving applications of, thermal and photovoltaic solar energy systems. Advances in technologies for harnessing solar energy are extensively discussed, with topics including the fabrication, compaction and optimization of energy grids, solar cells and panels. Leading international experts discuss the applications, challenges and future prospects of research in this increasingly vital field, providing a valuable resource for all researchers working in this field.

Status, Prospects, and Impediments

Solar Radiation

Proceedings of AMLTA 2021

Resource Assessment, Site Evaluation, System Design, Production Forecasting and Feasibility Studies

Fundamentals and Applications

A Numerical Approach for Complex Terrain

This book constitutes revised selected papers from the 4th ECML PKDD Workshop on Data Analytics for Renewable Energy Integration, DARE 2016, held in Riva del Garda, Italy, in September 2016. The 11 papers presented in this volume were carefully reviewed and selected for inclusion in this book and handle topics such as time series forecasting, the detection of faults, cyber security, smart grid and smart cities, technology integration, demand response and many others.

The book “Assessment of Renewable Energy Resources with Remote Sensing" focuses on disseminating scientific knowledge and technological developments for the assessment and forecasting of renewable energy resources using remote sensing techniques. The eleven papers inside the book provide an overview of remote sensing applications on hydro, solar, wind and geothermal energy resources and their major goal is to provide state of art knowledge to contribute with the renewable energy resource deployment, especially in regions where energy demand is rapidly expanding. Renewable energy resources have an intrinsic relationship with local environmental features and the regional climate. Even small and fast environment and/or climate changes can cause significant variability in power generation at different time and space scales. Methodologies based on remote sensing are the primary source of information for the development of numerical models that aim to support the planning and operation of an electric system with a substantial contribution of intermittent energy sources. In addition, reliable data and knowledge on renewable energy resource assessment are fundamental to ensure sustainable expansion considering environmental, financial and energetic security.

Renewable energy generation has been constantly increasing during recent years. Wind and solar have had the most significant growths among all renewable resources. Wind and solar resources are highly intermittent and dependent on meteorological parameters and climatic conditions. The power output of wind turbines is subject to various meteorological parameters, such as wind speed, wind direction, air temperature, relative humidity, etc., among which the wind speed is the most direct and influential factor in wind power generation. Solar photovoltaic (PV) power is a function of solar radiation. Wind speed and solar radiation time series data exhibit unique features which complicate their prediction. This makes wind and solar power forecasting challenging. Accurate wind and solar forecasting enhances the value of renewable energy by improving the reliability and economic feasibility of these resources. It also supports integrating solar and wind power into electric grids by reducing the integration and operation costs associated with these intermittent generation sources. This chapter provides an overview of the time series methods that can be used for more accurate wind and solar forecasting.

In recent years, several projects and studies have been launched towards the development and use of new methodologies, in order to assess, monitor, and support clean forms of energy. Accurate estimation of the available energy potential is of primary importance, but is not always easy to achieve. The present Special Issue on 'Renewable Energy Resource Assessment and Forecasting' aims to provide a holistic approach to the above issues, by presenting multidisciplinary methodologies and tools that are able to support research projects and meet today's technical, socio-economic, and decision-making needs. In particular, research papers, reviews, and case studies on the following subjects are presented: wind, wave and solar energy; biofuels; resource assessment of combined renewable energy forms; numerical models for renewable energy forecasting; integrated forecasted systems; energy for buildings; sustainable development; resource analysis tools and statistical models; extreme value analysis and forecasting for renewable energy resources.

Recent Advances

Data-Driven Forecasting for Grid-Connected Solar Power Plants

Renewable Energy: Forecasting and Risk Management

Fast Radiative Transfer Model for Solar Resource Assessment and Forecasting

Solar Irradiance Forecasting at Multiple Time Horizons and Novel Methods to Evaluate Uncertainty

Advanced Machine Learning Technologies and Applications

This book presents the refereed proceedings of the 6th International Conference on Advanced Machine Learning Technologies and Applications (AMLTA 2021) held in

Cairo, Egypt, during March 22–24, 2021, and organized by the Scientific Research Group of Egypt (SRGE). The papers cover current research Artificial Intelligence Against COVID-19, Internet of Things Healthcare Systems, Deep Learning Technology, Sentiment analysis, Cyber-Physical System, Health Informatics, Data Mining, Power and Control Systems, Business Intelligence, Social media, Control Design, and Smart Systems.

As environmental issues remain at the forefront of energy research, renewable energy is now an all-important field of study. And as smart technology continues to grow and be refined, its applications broaden and increase in their potential to revolutionize sustainability studies. This potential can only be fully realized with a thorough understanding of the most recent breakthroughs in the field. Research Advancements in Smart Technology, Optimization, and Renewable Energy is a collection of innovative research that explores the recent steps forward for smart applications in sustainability. Featuring coverage on a wide range of topics including energy assessment, neural fuzzy control, and biogeography, this book is ideally designed for advocates, policymakers, engineers, software developers, academicians, researchers, and students.

The Performance of Concentrated Solar Power (CSP) Systems: Analysis, Measurement, and Assessment offers a unique overview of the information on the state-of-the-art of analysis, measurement, and assessment of the performance of concentrated solar power (CSP) components and systems in a comprehensive, compact, and complete manner. Following an introductory chapter to CSP systems and the fundamental principles of performance assessment, individual chapters explore the component performance of mirrors and receivers. Further expert-written chapters look at system performance assessment, durability testing, and solar resource forecasting for CSP systems. A final chapter gives an outlook on the actual methods and instruments for performance and durability assessment that are under development. The Performance of Concentrated Solar Power (CSP) Systems: Analysis, Measurement, and Assessment is an essential reference text for research and development professionals and engineers working on concentrated solar power systems, as well as for postgraduate students studying CSP. Presents a unique, single literature source for a complete overview of the performance assessment tools and methods currently used for concentrated solar power (CSP) technology Written by a team of experts in the field of CSP Provides information on the state-of-the-art of modeling, measurement, and assessment of the performance of CSP components and systems in a comprehensive, compact, and complete manner

Forecasting is one of the enabling technologies for the integration of weather-dependent renewable resources (e.g., solar and wind) into the electric grid. Accurate forecasts can reduce operational costs associated with intra-day variability, reduce imbalance charges incurred by plant operators due to inaccurate energy bids, decrease utility costs associated with day-ahead scheduling (thereby reducing overall O&M costs), as well as assist grid operators with balancing energy demand schedules. As the market penetration of solar-based power generation continues to grow, accurate and reliable forecasting techniques become increasingly more important. In this work, two key areas of solar forecasting are advanced. First, we develop intra-day (>1-hour) and day-ahead (>24-hour) forecasting methods to directly predict the generation of operational solar power plants, without the need for intermediate solar irradiance forecasts and resource-to-power modeling. Here we take a data-driven approach, leveraging Machine Learning (ML) techniques and publicly available, spatially resolved meteorological and remote sensing datasets. The proposed methods are analyzed and validated using two grid-connected 1 MW photovoltaic (PV) power plants in California. Second, we develop a method to directly and efficiently estimate cloud optical properties from longwave remote sensing data. The output of solar-based power generation systems is strongly dependent on cloud cover and optical depth, but in most solar forecasting methodologies cloud optical properties are over-simplified due to a lack of real-time, accurate estimates. The proposed estimation method builds upon a two-stream, spectrally resolved infrared radiation model coupled with high-resolution (5-minute, 2 km) spectral satellite imagery. We show that the proposed method can provide real-time, accurate estimates of cloud optical depth (COD) and cloud top height for all-sky (clear or cloudy) conditions during both daytime and nighttime.

Renewable Energy Resource Assessment and Forecasting

Solar Resources Mapping

U.S. Department of Energy Workshop Report

Solar Radiation, Modelling and Remote Sensing

Assessment of Renewable Energy Resources with Remote Sensing

4th ECML PKDD Workshop, DARE 2016, Riva del Garda, Italy, September 23, 2016, Revised Selected Papers

This study presents options to fully unlock the world's vast solar PV potential over the period until 2050. It builds on IRENA's global roadmap to scale up renewables and meet climate goals.

Advances in Renewable Energies and Power Technologies: Volume 1: Solar and Wind Energies examines both the theoretical and practical elements of renewable energy sources, such as photovoltaics, solar, photothermal and wind energies. Yahyaoui and a team of expert contributors present the most up-to-date information and analysis on renewable energy generation technologies in this comprehensive resource. Covers the principles and methods of each technology, an analysis of their implementation, management and optimization, and related economic advantages and limitations. Features recent case studies and models of each technology. A valuable resource for anyone working in the renewable energy field or wanting to learn more about theoretical and technological aspects of the most recent inventions and research in the field. Offers a *comprehensive guide to the most advanced contemporary renewable power generation technologies written by a team of top experts Discusses the energy optimization, control and limitations of each technology, as well as a detailed economic study of the associated costs of implementation and management Includes global case studies and models to exemplify the technological possibilities and limitations of each power generation method*

Gathering selected, revised and extended contributions from the conference 'Forecasting and Risk Management for Renewable Energy FOREWER', which took place in Paris in June 2017, this book focuses on the applications of statistics to the risk management and forecasting problems arising in the renewable energy industry. The different contributions explore all aspects of the energy production chain: forecasting and probabilistic modelling of renewable resources, including probabilistic forecasting approaches; modelling and forecasting of wind and solar power production; prediction of electricity demand; optimal operation of microgrids involving renewable production; and finally the effect of renewable production on electricity market prices. Written by experts in statistics, probability, risk management, economics and electrical engineering, this multidisciplinary volume will serve as a reference on renewable energy risk management and at the same time as a source of inspiration for statisticians and probabilists aiming to work on energy-related problems.

Photovoltaic (PV) and concentrated solar power (CSP) systems for the conversion of solar energy into electricity are technologically robust, scalable, and geographically dispersed, and they possess enormous potential as sustainable energy sources. Systematic planning and design considering various factors and constraints are necessary for the successful deployment of PV and CSP systems. This book on solar power system planning and design includes 14 publications from esteemed research groups worldwide. The research and review papers in this Special Issue fall within the following broad categories: resource assessments, site evaluations, system design, performance assessments, and feasibility studies.

Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications

Real-time Forecasting for Renewable Energy Development

Time Series Analysis and Applications

Solar Energy Forecasting and Resource Assessment

From Models to Applications

Data Analytics for Renewable Energy Integration

The rather specialized field of solar and infrared radiation measurements has become increasingly important due to the increased demands by the renewable energy and climate change research communities for data with higher accuracy and increased temporal and spatial resolutions. Recent advances in radiometry, measurement systems, and information dissemination also have increased the need for refreshing the literature available for this topic. This book provides the reader with an up-to-date review of the important aspects of solar and infrared radiation measurements: radiometer design; equipment installation, operation, maintenance, and calibration; data quality assessment parameters; and the knowledge necessary to properly interpret and apply the measured data to a variety of topics. Each of the authors has more than 40 years of experience with this subject, primarily as the result of developing and operating multiple measurement stations, working with the industry to improve radiometry, and conducting various research projects. The book's scope and subject matter have been designed to help a wide audience gain a general understanding of this subject and to serve as a technical reference. A student new to the field will benefit from the review of terminology and the historical perspective for radiometry before addressing more detailed topics in radiometry that we hope will be of interest to the more experienced reader. ? Describes the strengths and weaknesses of irradiance instruments ? Provides detailed information on how to assess uncertainty in measurements ? Offers comprehensive background information needed to understand the use of solar instrumentation ? Discusses design concepts for shadowband radiometers, sky imagers, and satellite-based estimates of solar irradiance at the Earth's surface ? Includes chapter-end questions, references, and useful links

In addition to describing core concepts and principles, this book reveals professional methodologies and tools used by national agencies and private corporations to predict sites' potential for wind and solar power generation. Each chapter focuses on a different issue, showing readers the corresponding methodology, as well as examples of how to apply the techniques described. These techniques are explained with step-by-step guides that demonstrate how environmental variables in complex terrains can be characterized and forecasted.The authors present an adaptive finite element mass-consistent model, which computes a diagnostic wind field in the three-dimensional area of interest using observed wind data from measurement stations – data which is then interpolated using a physical model of the wind field in the boundary layer. An ensemble method is presented based on the perturbation of the numerical weather prediction models' results. The book goes on to explain solar radiation characterization and forecasting. Solar radiation and electrical power generation temporal and spatial variability are discussed and modelled. Different statistical methods are presented in order to improve solar radiation forecasting using ground measurement, numerical weather predictions (NWPs) and satellite-derived data. This book is focused on both probabilistic and point forecast explaining different models and methodologies to improve the forecasting. The results obtained from various simulations around the world are presented in tables. Finally, the book explains a possible methodology to develop a Solar Map taking into account solar radiation, terrain surface conditions and cast shadows. As such, the book provides an overview of the concepts, principles and practices involved in the treatment of environmental variables related to solar radiation or wind fields, especially when complex terrains are involved, offering useful resources for students and researchers alike. It also equips professionals with the methodologies and tools needed to construct environmental variable maps and conduct forecasting for solar radiation and wind fields.

This open access book presents the proceedings of the 3rd Indo-German Conference on Sustainability in Engineering held at Birla Institute of Technology and Science, Pilani, India, on September 16–17, 2019. Intended to foster the synergies between research and education, the conference is one of the joint activities of the BITS Pilani and TU Braunschweig conducted under the auspices of Indo-German Center for Sustainable Manufacturing, established in 2009. The book is divided into three sections: engineering, education and entrepreneurship, covering a range of topics, such as renewable energy forecasting, design & simulation, Industry 4.0, and soft & intelligent sensors for energy efficiency. It also includes case studies on lean and green manufacturing, and life cycle analysis of ceramic products, as well as papers on teaching/learning methods based on the use of learning factories to improve students'problem-solving and personal skills. Moreover, the book discusses high-tech ideas to help the large number of unemployed engineering graduates looking for jobs become tech entrepreneurs. Given its broad scope, it will appeal to academics and industry professionals alike.

Time Series Analysis (TSA) and Applications offers a dense content of current research and development in the field of data science. The book presents time series from a multidisciplinary approach that covers a wide range of sectors ranging from biostatistics to renewable energy forecasting. Contrary to previous literatures on time, serious readers will discover the potential of TSA in areas other than finance or weather forecasting. The choice of the algorithmic transform for different scenarios, which is a key determinant in the application of TSA, can be understood through the diverse domain applications. Readers looking for deep understanding and practicability of TSA will be delighted. Early career researchers too will appreciate the technicalities and refined mathematical complexities surrounding TSA. Our wish is that this book adds to the body of TSA knowledge and opens up avenues for those who are looking forward to applying TSA in their own context.

Enhancing Future Skills and Entrepreneurship

Renewable Resource Management at UC San Diego

Practical Modeling for Renewable Energy Applications

Solar Power System Planning & Design

Advanced Statistical Modeling, Forecasting, and Fault Detection in Renewable Energy Systems

California Renewable Energy Forecasting, Resource Data, and Mapping

In recent years, several projects and studies have been launched towards the development and use of new methodologies, in order to assess, monitor, and support clean forms of energy. Accurate estimation of the available energy potential is of primary importance, but is not always easy to achieve. The present Special Issue on ‘Renewable Energy Resource Assessment and Forecasting’ aims to provide a holistic approach to the above issues, by presenting multidisciplinary methodologies and tools that are able to support research projects and meet today’s technical, socio-economic, and decision-making needs. In particular, research papers, reviews, and case studies on the following subjects are presented: wind, wave and solar energy; biofuels; resource assessment of combined renewable energy forms; numerical models for renewable energy forecasting; integrated forecasted systems; energy for buildings; sustainable development; resource analysis tools and statistical models; extreme value analysis and forecasting for renewable energy resources.

Accurate solar radiation knowledge and its characterization on the Earth’s surface are of high interest in many aspects of environmental and engineering sciences. Modeling of solar irradiance from satellite imagery has become the most widely used method for retrieving solar irradiance information under total sky conditions, particularly in the solar energy community. Solar radiation modeling, forecasting, and characterization continue to be broad areas of study, research, and development in the scientific community. This Special Issue contains a small sample of the current activities in this field. Both the environmental and climatology community, as the solar energy world, share a great interest in improving modeling tools and capabilities for obtaining more reliable and accurate knowledge of solar irradiance components worldwide. The work presented in this Special Issue also remarks on the significant role that remote sensing technologies play in retrieving and forecasting solar radiation information.

In the past decade, there has been a substantial increase of grid-feeding photovoltaic applications, thus raising the importance of solar electricity in the energy mix. This trend is expected to continue and may even increase. Apart from the high initial investment cost, the fluctuating nature of the solar resource raises particular insertion problems in electrical networks. Proper grid managing demands short- and long-time forecasting of solar power plant output. Weather modeling and forecasting of PV systems operation is focused on this issue. Models for predicting the state of the sky, nowcasting solar irradiance and forecasting solar irradiation are studied and exemplified. Statistical as well as artificial intelligence methods are described. The efficiency of photovoltaic converters is assessed for any weather conditions. Weather modeling and forecasting of PV systems operation is written for researchers, engineers, physicists and students interested in PV systems design and utilization. “p>

Proceedings of the First Workshop on Terrestrial Solar Resource Forecasting and on Use of Satellites for Terrestrial Solar Resource Assessment, February 2-5, 1981, Washington, D.C.

Advances in Solar Energy Research

Translating the Paris Agreement into Action in the Pacific

Final Project Report

Photovoltaics for Sustainable Electricity and Buildings

Advances in Renewable Energies and Power Technologies