



Smart and Sustainable Power Systems

Operations, Planning, and Economics
of Insular Electricity Grids

EDITED BY

João P. S. Catalão



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UNIVERSITY OF BEIRA INTERIOR, COVILHA, PORTUGAL



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*I dedicate this book to Carla and Alex,
for inspiring me with their love and energy.*

Preface

To foster the transition toward a sustainable energy future, islands represent a priority test bed for pioneering technologies such as smart grids, alongside renewable energy sources and electrical energy storage devices. The smart grid initiative, integrating advanced sensing technologies, intelligent control methods, and bidirectional communications into the contemporary electricity grid, provides excellent opportunities for energy efficiency improvements and better integration of distributed generation, coexisting with centralized generation units within an active network.

A large share of the installed capacity for recent renewable energy sources already comprises insular electricity grids, since the latter are preferable due to their high potential for renewables. However, the increasing share of renewables in the power generation mix of insular power systems presents a significant challenge to efficient management of the insular distribution networks, mainly due to the variability and uncertainty of renewable generation.

More than other electricity grids, insular electricity grids require the incorporation of sustainable resources and the maximization of the integration of local resources, as well as specific solutions to cope with the inherent characteristics of renewable generation. Insular power systems need a new generation of methodologies and tools to face the new paradigm of large-scale renewable integration.

This book deals with modeling, simulation, and optimization of insular power systems to address the effects of large-scale integration of renewables and demand-side management, from forecasting to operations and planning and proposing efficient methodologies, tools, and solutions toward the development of a sustainable and smart grid. Comprehensive testing and validation of the mathematical models are provided using real-world data.

This book covers several important topics, such as insular power systems, forecast techniques and models, renewable energies, uncertainty and variability, power flow calculations, probabilistic and stochastic approaches, scenario generation, scheduling models, short-term operation, reserves and demand response, electric price signals, competitive operation of distribution networks, and network expansion planning.

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Editor

João P. S. Catalão received a master's degree from the Instituto Superior Técnico, Lisbon, Portugal, in 2003, and a PhD degree and habilitation for full professor ("Agregação") from the University of Beira Interior (UBI), Covilhã, Portugal, in 2007 and 2013, respectively.

Currently, he is a professor at UBI, director of the Sustainable Energy Systems Lab, and researcher at INESC-ID. He is a senior member of IEEE. He is the primary coordinator of the EU-funded FP7 project SiNGULAR (Smart and Sustainable Insular Electricity Grids Under Large-Scale Renewable Integration), a €5.2-million project involving 11 industry partners. He has authored or coauthored more than 320 publications, including 100 journal papers, 200 conference proceedings papers, and 20 book chapters, with an *h*-index of 22 (according to Google Scholar). He has supervised more than 25 postdoctoral, PhD, and MSc students. He is the editor of the book entitled *Electric Power Systems: Advanced Forecasting Techniques and Optimal Generation Scheduling* (Boca Raton, FL: CRC Press, 2012), translated into Chinese in January 2014. His research interests include power system operations and planning, hydro and thermal scheduling, wind and price forecasting, distributed renewable generation, demand response, and smart grids.

Professor Catalão is an editor of *IEEE Transactions on Smart Grid*, an editor of *IEEE Transactions on Sustainable Energy*, and an associate editor of *IET Renewable Power Generation*. He was the guest editor-in-chief for the special section "Real-Time Demand Response" of *IEEE Transactions on Smart Grid*, published in December 2012, and he is currently guest editor-in-chief for the special section "Reserve and Flexibility for Handling Variability and Uncertainty of Renewable Generation" of *IEEE Transactions on Sustainable Energy*. He is the recipient of the 2011 Scientific Merit Award UBI-FE/Santander Universities and the 2012 Scientific Award UTL/Santander Totta.

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