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Building-Integrated Photovoltaic Systems (BIPVS)

Performance and Modeling Under Outdoor Conditions

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ISBN 978-3-319-71930-6 ISBN 978-3-319-71931-3 (eBook)
https://doi.org/10.1007/978-3-319-71931-3

Library of Congress Control Number: 2017959884

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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Introduction

Electricity generation located near the energy load is called distributed generation. The hardware is typically installed in the same area as the energy demand. There is a wide variety of technology that covers distributed generation, although their use is based on availability.

The present work reports on the design, installation, and start-up of the building integrated photovoltaic system (BIPVS) that is connected to the low-voltage grid of the Universidad de Bogotá Jorge Tadeo Lozano's Engineering Programs' Center for Research (CIPI). It also describes a mathematical analysis that models the behavior of a solar panel in the system. This book also presents the design and installation of a monitoring system for the performance of the solar plant that uses virtual instrumentation and analysis of the results of the photovoltaic (PV) generator and inverter.

The photovoltaic generator is made up of 24 solar panels, Trina Solar, of 250 W each and a Sunny Boy two-phase inverter of 5000 W. The results of the modeling stage indicate a relative error of 1.5% between the maximum power point reported by the solar panel manufacturer and the proposed mathematical analysis under a solar radiation level of 1000 W/m^2. The main results of the performance monitoring analysis of the BIPVS system show that over a period of two years, 16.194 kWh was generated and the harmonics, nominal voltage, and system frequency have been within the operating ranges suggested by the IEEE 929-2000 standard. Solar radiation has exceeded 4 kWh/m^2-day.

The book consists of 12 chapters, providing a comprehensive overview of the topic at hand.

Chapter 1 presents the current state of energy worldwide, with emphasis on its utilization in Colombia.

Chapter 2 corresponds to the conceptual framework of the work developed. It provides a global view on distributed energy generation and applies the concepts of BIPVS, with its respective form of operation and distributed generation (DG), among other concepts.

Chapter 3 provides the basics of the BIPVS sizing, power quality, monitoring system, and virtual instrumentation.

Chapter 4 reviews a BIPVS application on a 40 story building.

Chapter 5 focuses on the sizing and implementation of the BIPVS installed at the Universidad de Bogotá Jorge Tadeo Lozano as an object of research and development.

Chapter 6 describes solar cell characteristics and presents a method for calculating short-circuit spectral current density and quantum efficiency.

Chapter 7 corresponds to the modeling and characterization stage of the photovoltaic solar panel to determine the reliability of the implemented model's operation.

Chapter 8 covers detailed implementation of the monitoring system to carry out the acquisition of environmental and electrical parameters of the photovoltaic generation system. These parameters include all the physical elements of the system such as equipment, transducers, power lines, protections, acquisition cards, and PC.

Chapter 9 refers to the performance, behavior, and analysis of BIPVS.

Chapter 10 corresponds to stable state analysis of the power system incorporating a 6 kW photovoltaic generator to the low-voltage grid of the CIPI building.

Chapter 11 evaluates BIPVS power generation through the use of neural networks.

Chapter 12 refers to the analysis and economic viability of the photovoltaic system implemented at the UTADEO University through the RETScreen software.