Control Of Distributed Generation And Storage Operation

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The Law of Distributed Generation
Communication and Control in Electric Power Systems

CINDY SHERMAN

Microgrid CRC Press
The economics and locations of sustainable energy sources have meant that many of these new generators are connected into distribution networks. It is recognized that the information flow and control of distribution networks is inadequate for these future low-carbon electricity supply systems. The future distribution network will change its operation from passive to active, and the distributed generators will be controlled to support the operation of the power system. In many countries this transformation of electricity supply is managed through energy markets and privately owned, regulated transmission and distribution systems. --
Robust Implementation of Algorithms for Distributed Generation Control of Small-footprint Power Systems IntechOpen
Integrating renewable energy and other distributed energy sources into smart grids, often via power inverters, is arguably the largest “new frontier” for smart grid advancements. Inverters should be controlled properly so that their integration does not jeopardize the stability and performance of power systems and a solid technical backbone is formed to facilitate other functions and services of smart grids. This unique reference offers systematic treatment of important control problems in power inverters, and different general converter theories. Starting at a basic level, it presents conventional power conversion methodologies and then ‘non-conventional’ methods, with a highly accessible summary of the latest developments in power inverters as well as insight into the grid connection of renewable power. Consisting of four parts – Power Quality Control, Neutral Line Provision, Power Flow Control, and Synchronisation – this book fully demonstrates the integration of control and power electronics. Key features include: the fundamentals of power processing and hardware design innovative control strategies to systematically treat the control of power inverters extensive experimental results for most of the control strategies presented the pioneering work on “synchronverters” which has gained IET Highly Commended Innovation Award Engineers working on inverter design and those at power system utilities can learn how advanced control strategies could improve system performance and work in practice. The book is a useful reference for researchers who are interested in the area of control engineering, power electronics, renewable energy and distributed generation, smart grids, flexible AC transmission systems, and power systems for more-electric aircraft and all-electric ships. This is also a handy text for graduate students and university professors in the areas of electrical power engineering, advanced control engineering, power electronics, renewable energy and smart grid integration.
Modeling, Stability Analysis, and Control of Distributed Generation in the Context of Microgrids John Wiley & Sons
The first extensive reference on these important techniques The restructuring of the electric utility industry has created the need for a mechanism that can effectively coordinate the various entities in a power market, enabling them to communicate efficiently and perform at an optimal level. Communication and Control in Electric Power Systems, the first resource to address its subject in an extended format, introduces parallel and distributed processing techniques as a compelling solution to this critical problem. Drawing on their years of experience in the industry, Mohammad Shahidehpour and Yaoyu Wang deliver comprehensive coverage of parallel and distributed processing techniques with a focus on power system optimization, control, and communication. The authors begin with theoretical background and an overview of the increasingly deregulated power market, then move quickly into the practical applications and implementations of these pivotal techniques. Chapters include: Integrated Control Center Information Parallel and Distributed Computation of Power Systems Common Information Model and Middleware for Integration Online Distributed Security Assessment and Control Integration, Control, and Operation of Distributed Generation Agent Theory and Power Systems Management e-Commerce of Electricity A ready resource for both students and practitioners, Communication and Control in Electric Power Systems proves an ideal textbook for first-year graduate students in power engineering with an interest in computer communication systems and control center design. Designers, operators, planners, and researchers will likewise appreciate its unique contribution to the professional literature.
Control of Distributed Generation and Storage Academic Press
This book provides the insight of various topology and control algorithms used for power control in distributed renewable energy power conversion systems. It covers control algorithms of power filtering including modeling and simulations, and hybrid power generation system including adaptive/model predictive/fuzzy/AI based controllers.
Grid-Integrated and Standalone Photovoltaic Distributed Generation Systems BoD – Books on Demand
This book features extensive coverage of all Distributed Energy Generation technologies, highlighting the technical, environmental and economic aspects of distributed resource integration, such as line loss reduction, protection, control, storage, power electronics, reliability improvement, and voltage profile optimization. It explains how electric power system planners, developers, operators, designers, regulators and policy makers can derive many benefits with increased penetration of distributed generation units into smart distribution networks. It further demonstrates how to best realize these benefits via skillful integration of distributed energy sources, based upon an understanding of the characteristics of loads and network configuration.
Modeling and Control of Fuel Cells John Wiley & Sons
"The transformation of the electric grid from the traditional central station model to a more dynamic and interconnected system of distributed generation and distribution is a huge change in our lives, and yet one that is barely noticeable in day-to-day life unless you actually are looking for it. If you are looking, though, the rate of change is breathtaking. I know this first hand because in the roughly three years we have been working on this book the landscape already has evolved dramatically. In this time, topics we thought were interesting, such as battery storage, became drivers to the

discussion while other topics faded in relevance. Indeed, one of the challenges of writing this book is our effort to assemble information that would remain interesting and useful to readers even as the technology and the law advanced. With the help of all of the authors and other contributors to this project, I think we have achieved this"--

Energy Management of Distributed Generation Systems John Wiley & Sons

This text is an introduction to the use of control in distributed power generation. It shows the reader how reliable control can be achieved so as to realize the potential of small networks of diverse energy sources, either singly or in coordination, for meeting concerns of energy cost, energy security and environmental protection. The book demonstrates how such microgrids, interconnecting groups of generating units and loads within a local area, can be an effective means of balancing electrical supply and demand. It takes advantage of the ability to connect and disconnect microgrids from the main body of the power grid to give flexibility in response to special events, planned or unplanned. In order to capture the main opportunities for expanding the power grid and to present the plethora of associated open problems in control theory Control and Optimization of Distributed Generation Systems is organized to treat three key themes, namely: system architecture and integration; modelling and analysis; and communications and control. Each chapter makes use of examples and simulations and appropriate problems to help the reader study. Tools helpful to the reader in accessing the mathematical analysis presented within the main body of the book are given in an appendix. Control and Optimization of Distributed Generation Systems will enable readers new to the field of distributed power generation and networked control, whether experienced academic migrating from another field or graduate student beginning a research career, to familiarize themselves with the important points of the control and regulation of microgrids. It will also be useful for practising power engineers wishing to keep abreast of changes in power grids necessitated by the diversification of generating methods.

Architectures and Algorithms for Distributed Generation Control of Microgrids Springer Nature

Integration of Distributed Energy Resources in Power Systems: Implementation, Operation and Control covers the operation of power transmission and distribution systems and their growing difficulty as the share of renewable energy sources in the world’s energy mix grows and the proliferation trend of small scale power generation becomes a reality. The book gives students at the graduate level, as well as researchers and power engineering professionals, an understanding of the key issues necessary for the development of such strategies. It explores the most relevant topics, with a special focus on transmission and distribution areas. Subjects such as voltage control, AC and DC microgrids, and power electronics are explored in detail for all sources, while not neglecting the specific challenges posed by the most used variable renewable energy sources. Presents the most relevant aspects of the integration of distributed energy into power systems, with special focus on the challenges for transmission and distribution Explores the state-of the-art in applications of the most current technology, giving readers a clear roadmap Deals with the technical and economic features of distributed energy resources and discusses their business models

Performance Control of Distributed Generation Using Digital Estimation of Signal Parameters Butterworth-Heinemann

Distributed Generation Systems: Design, Operation and Grid Integration closes the information gap between recent research on distributed generation and industrial plants, and provides solutions to their practical problems and limitations. It provides a clear picture of operation principles of distributed generation units, not only focusing on the power system perspective but targeting a specific need of the research community. This book is a useful reference for practitioners, featuring worked examples and figures on principal types of distributed generation with an emphasis on real-world examples, simulations, and illustrations. The book uses practical exercises relating to the concepts of operating and integrating DG units to distribution networks, and helps engineers accurately design systems and reduce maintenance costs. Provides examples and datasheets of principal systems and commercial data in MATLAB Presents guidance for accurate system designs and maintenance costs Identifies trouble shooting references for engineers Closes the information gap between recent research on distributed generation and industrial plants

Distributed Energy Systems Academic Press

We take the perspective of a microgrid that has installed distribution energy resources (DER) in the form of distributed generation with combined heat and power applications. Given uncertain electricity and fuel prices, the microgrid minimizes its expected annual energy bill for various capacity sizes. In almost all cases, there is an economic and environmental advantage to using DER in conjunction with demand response (DR): the expected annualized energy bill is reduced by 9percent while CO2 emissions decline by 25percent. Furthermore, the microgrid's risk is diminished as DER may be deployed depending on prevailing market conditions and local demand. In order to test a policy measure that would place a weight on CO2 emissions, we use a multi-criteria objective function that minimizes a weighted average of expected costs and emissions. We find that greater emphasis on CO2 emissions has a beneficial environmental impact only if DR is available and enough reserve generation capacity exists. Finally, greater uncertainty results in higher expected costs and risk exposure, the effects of which may be mitigated by selecting a larger capacity.

Integration of Distributed Generation in the Power System BoD – Books on Demand

In the recent years the electrical power utilities have undergone rapid restructuring process worldwide. Indeed, with deregulation, advancement in technologies and concern about the environmental impacts, competition is particularly fostered in the generation side, thus allowing increased interconnection of generating units to the utility networks. These generating sources are called distributed generators (DG) and defined as the plant which is directly connected to distribution network and is not centrally planned and dispatched. These are also called embedded or dispersed generation units. The rating of the DG systems can vary between few kW to as high as 100 MW. Various new types of distributed generator systems, such as microturbines and fuel cells in addition to the more traditional solar and wind power are creating significant new opportunities for the integration of diverse DG systems to the utility. Interconnection of these generators will offer a number of benefits such as improved reliability, power quality, efficiency, alleviation of system constraints along with the environmental benefits. Unlike centralized power plants, the DG units are directly connected to the distribution system; most often at the customer end. The existing distribution networks are designed and operated in radial configuration with unidirectional power flow from centralized generating station to customers. The increase in interconnection of DG to utility networks can lead to reverse power flow violating fundamental assumption in their design.

This creates complexity in operation and control of existing distribution networks and offers many technical challenges for successful introduction of DG systems. Some of the technical issues are islanding of DG, voltage regulation, protection and stability of the network. Some of the solutions to these problems include designing standard interface control for individual DG systems by taking care of their diverse characteristics, finding new ways to/or install and control these DG systems and finding new design for distribution system. DG has much potential to improve distribution system performance. The use of DG strongly contributes to a clean, reliable and cost effective energy for future. This book deals with several aspects of the DG systems such as benefits, issues, technology interconnected operation, performance studies, planning and design. Several authors have contributed to this book aiming to benefit students, researchers, academics, policy makers and professionals. We are indebted to all the people who either directly or indirectly contributed towards the publication of this book.

Control of Power Inverters in Renewable Energy and Smart Grid Integration Springer

The book contains 10 chapters, and it is divided into four sections. The first section includes three chapters, providing an overview of Energy Management of Distributed Systems. It outlines typical concepts, such as Demand-Side Management, Demand Response, Distributed, and Hierarchical Control for Smart Micro-Grids. The second section contains three chapters and presents different control algorithms, software architectures, and simulation tools dedicated to Energy Management Systems. In the third section, the importance and the role of energy storage technology in a Distribution System, describing and comparing different types of energy storage systems, is shown. The fourth section shows how to identify and address potential threats for a Home Energy Management System. Finally, the fifth section discusses about Economical Optimization of Operational Cost for Micro-Grids, pointing out the effect of renewable energy sources, active loads, and energy storage systems on economic operation.

Migrogrids and Distributed Generation Systems Academic Press

A practical and systematic elaboration on the analysis, design and control of grid integrated and standalone distributed photovoltaic (PV) generation systems, with Matlab and Simulink models Analyses control of distribution networks with high penetration of PV systems and standalone microgrids with PV systems Covers in detail PV accommodation techniques including energy storage, demand side management and PV output power regulation Features examples of real projects/systems given in OPENDSS codes and/or Matlab and Simulink models Provides a concise summary of up-to-date research around the word in distributed PV systems

Optimal Control of Distributed Energy Resources and Demand Response Under Uncertainty IET

One of the consequences of competitive electricity markets and international commitments to green energy is the fast development and increase in the amount of distributed generation (DG) in distribution grids. These DGs are resulting in a change in the nature of distribution systems from being "passive", containing only loads, to "active", including loads and DGs. This will affect the dynamic behavior of both transmission and distribution systems. There are many technical aspects and challenges of DGs that have to be properly understood and addressed. One of them is the need for adequate static and dynamic models for DG units, particularly under unbalanced conditions, to perform proper studies of distribution systems with DGs (e.g., microgrids). The primary objective of this thesis is the development and implementation of dynamic and static models of various DG technologies for stability analysis. These models allow studying systems with DGs both in the long- and short-term; thus, differential and algebraic equations of various DGs are formulated and discussed in order to integrate these models into existing power system analysis software tools. The presented and discussed models are generally based on dynamic models of different DGs for stability studies considering the dynamics of the primary governor, generators, and their interfaces and controls. A new comprehensive investigation is also presented of the effects of system unbalance on the stability of distribution grids with DG units based on synchronous generator (SG) and doubly-fed induction generator (DFIG) at different loading levels. Detailed steady-state and dynamic analyses of the system are performed. Based on voltage and angle stability studies, it is demonstrated that load unbalance can significantly affect the distribution system dynamic performance. Novel, simple, and effective control strategies based on an Unbalanced Voltage Stabilizer (UVS) are also proposed to improve the system control and the stability of unbalanced distribution systems with SG- and DFIG-based DGs.

Electric Distribution Network Management and Control John Wiley & Sons

Microgrids: Advanced Control Methods and Renewable Energy System Integration demonstrates the state-of-art of methods and applications of microgrid control, with eleven concise and comprehensive chapters. The first three chapters provide an overview of the control methods of microgrid systems that is followed by a review of distributed control and management strategies for the next generation microgrids. Next, the book identifies future research directions and discusses the hierarchical power sharing control in DC Microgrids. Chapter 4 investigates the demand side management in microgrid control systems from various perspectives, followed by an outline of the operation and controls of the smart microgrids in Chapter 5. Chapter 6 deals with control of low-voltage microgrids with master/slave architecture. The final chapters explain the load-Frequency Controllers for Distributed Power System Generation Units and the issue of robust control design for VSIs, followed by a communication solution denoted as power talk. Finally, in Chapter 11, real-time implementation of distributed control for an autonomous microgrid system is performed. Addresses issues of contemporary interest to practitioners in the power engineering and management fields Focuses on the role of microgrids within the overall power system structure and attempts to clarify the main findings relating to primary and secondary control and management at the microgrid level Provides results from a quantified assessment of benefits from economic, environmental, operational, and social point-of-views Presents the hierarchical control levels manifested in microgrid operations and evaluates the principles and main functions of centralized and decentralized control

Handbook of Distributed Generation CRC Press

This book highlights the recent research advances in the area of operation, management and control of electricity distribution networks. It addresses various aspects of distribution network management, including operation, customer engagement and technology accommodation. Electricity distribution networks are an important part of the power delivery system, and the smart control and management of distribution networks is vital in order to satisfy technical, economic, and customer requirements. A new management philosophy, techniques, and methods are essential to handle uncertainties, security, and stability associated with the integration of renewable-based

distributed generation units, demand forecast and customer needs. This book discusses these topics in the context of managing the capacity of distribution networks while addressing the future needs of electricity systems. Furthermore, the efficient and economic operation of distribution networks is an essential part of management of system for effective use of resources, and as such the also addresses operation and control approaches and techniques suitable for future distribution networks.

MICROGRIDS Nova Science Publishers

This book provides the insight of various topology and control algorithms used for power control in distributed energy power conversion systems such as solar, wind, and other power sources. It covers traditional and advanced control algorithms of power filtering including modelling and simulations, and hybrid power generation systems. The adaptive control, model predictive control, fuzzy-based controllers, Artificial Intelligence-based control algorithm, and optimization techniques application for estimating the error regulator gains are discussed. Features of this book include the following: Covers the schemes for power quality enhancement, and voltage and frequency control. Provides complete mathematical modelling and simulation results of the various configurations of the renewable energy-based distribution systems. Includes design, control, and experimental results. Discusses mathematical modelling of classical and adaptive control techniques. Explores recent application of control algorithm and power conversion. This book is aimed at researchers, professionals, and graduate students in power electronics, distributed power generation systems, control engineering, Artificial Intelligent-based control algorithms, optimization techniques, and renewable energy systems.

Distributed Power Resources BoD – Books on Demand

Distributed generation systems (DGs) have been penetrating into our energy networks with the advancement in the renewable energy sources and energy storage elements. These systems can operate in synchronism with the utility grid referred to as the grid connected (GC) mode of operation, or work independently, referred to as the standalone (SA) mode of operation. There is a need to ensure continuous power flow during transition between GC and SA modes, referred to as the transition mode, in operating DGs. In this dissertation, efficient and effective transition control algorithms are developed for DGs operating either independently or collectively with other units. Three techniques are proposed in this dissertation to manage the proper transition operations. In the first technique, a new control algorithm is proposed for an independent DG which can operate in SA and GC modes. The proposed transition control algorithm ensures low total harmonic distortion (THD) and less voltage fluctuation during mode transitions compared to the other techniques. In the second technique, a transition control is suggested for a collective of DGs operating in a microgrid system architecture to improve the reliability of the system, reduce the cost, and provide better performance. In this technique, one of the DGs in a microgrid system, referred to as a dispatch unit, takes the additional responsibility of mode transitioning to ensure smooth transition and supply/demand balance in the microgrid. In the third technique, an alternative transition technique is proposed through hybridizing the current and droop controllers. The proposed hybrid transition control technique has higher reliability compared to the dispatch unit concept. During the GC mode, the proposed hybrid controller uses current control. During the SA mode, the hybrid controller uses droop control. During the transition mode, both of the controllers participate in formulating the inverter output voltage but with different weights or coefficients. Voltage source inverters interfacing the DGs as well as the proposed transition control algorithms have been modeled to analyze the stability of the algorithms in different configurations. The performances of the proposed algorithms are verified through simulation and experimental studies. It has been found that the proposed control techniques can provide smooth power flow to the local loads during the GC, SA and transition modes.

Decentralized Control Techniques Applied to Electric Power Distributed Generation in Microgrids Springer

In the recent years the electrical power utilities have undergone rapid restructuring process worldwide. Indeed, with deregulation, advancement in technologies and concern about the environmental impacts, competition is particularly fostered in the generation side, thus allowing increased interconnection of generating units to the utility networks. These generating sources are called distributed generators (DG) and defined as the plant which is directly connected to distribution network and is not centrally planned and dispatched. These are also called embedded or dispersed generation units. The rating of the DG systems can vary between few kW to as high as 100 MW. Various new types of distributed generator systems, such as microturbines and fuel cells in addition to the more traditional solar and wind power are creating significant new opportunities for the integration of diverse DG systems to the utility. Interconnection of these generators will offer a number of benefits such as improved reliability, power quality, efficiency, alleviation of system constraints along with the environmental benefits. Unlike centralized power plants, the DG units are directly connected to the distribution system; most often at the customer end. The existing distribution networks are designed and operated in radial configuration with unidirectional power flow from centralized generating station to customers. The increase in interconnection of DG to utility networks can lead to reverse power flow violating fundamental assumption in their design. This creates complexity in operation and control of existing distribution networks and offers many technical challenges for successful introduction of DG systems. Some of the technical issues are islanding of DG, voltage regulation, protection and stability of the network. Some of the solutions to these problems include designing standard interface control for individual DG systems by taking care of their diverse characteristics, finding new ways to/or install and control these DG systems and finding new design for distribution system. DG has much potential to improve distribution system performance. The use of DG strongly contributes to a clean, reliable and cost effective energy for future. This book deals with several aspects of the DG systems such as benefits, issues, technology interconnected operation, performance studies, planning and design. Several authors have contributed to this book aiming to benefit students, researchers, academics, policy makers and professionals. We are indebted to all the people who either directly or indirectly contributed towards the publication of this book.

Development and Implementation of Control Strategies for Effective Management of Distributed Energy Resources John Wiley & Sons

The book presents the latest power conversion and control technology in modern wind energy systems. It has nine chapters, covering technology overview and market survey, electric generators

and modeling, power converters and modulation techniques, wind turbine characteristics and configurations, and control schemes for fixed- and variable-speed wind energy systems. The book also provides in-depth steady-state and dynamic analysis of squirrel cage induction generator, doubly fed induction generator, and synchronous generator based wind energy systems. To illustrate the key concepts and help the reader tackle real-world issues, the book contains more than 30 case studies and 100 solved problems in addition to simulations and experiments. The book serves as a comprehensive reference for academic researchers and practicing engineers. It can also be used as a textbook for graduate students and final year undergraduate students.

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