Advanced Grid Modeling Department Of Energy

Electric power systems are being transformed from older grid systems to smart grids across the globe. The goals of this transition are to address today's electric power issues, which include reducing carbon footprints, finding alternate sources of decaying fossil fuels, eradicating losses that occur in the current available systems, and introducing the latest information and communication technologies (ICT) for electric grids. The development of smart grid technology is advancing dramatically along with and in reaction to the continued growth of renewable energy technologies (especially wind and solar power), the growing popularity of electric vehicles, and the continuing huge demand for electricity. Smart Grid Systems: Modeling and Control advances the basic understanding of smart grids and focuses on recent technological advancements in the field. This book provides a comprehensive discussion from a number of experts and

practitioners and describes the challenges and the future scope of the technologies related to smart grid. Key features: provides an overview of the smart grid, with its needs, benefits, challenges, existing structure, and possible future technologies discusses solar photovoltaic (PV) system modeling and control along with battery storage, an integral part of smart grids discusses control strategies for renewable energy systems, including solar PV, wind, and hybrid systems describes the inverter topologies adopted for integrating renewable power covers the basics of the energy storage system and the need for micro grids describes forecast techniques for renewable energy systems presents the basics and structure of the energy management system in smart grids, including advanced metering, various communication protocols, and the cyber security challenges explores electric vehicle technology and its interaction with smart grids

The first book in the field to incorporate fundamentals of energy systems and their applications to smart

grid, along with advanced topics in modeling and control This book provides an overview of how multiple sources and loads are connected via power electronic devices. Issues of storage technologies are discussed, and a comparison summary is given to facilitate the design and selection of storage types. The need for real-time measurement and controls are pertinent in future grid, and this book dedicates several chapters to real-time measurements such as PMU, smart meters, communication scheme, and protocol and standards for processing and controls of energy options. Organized into nine sections, Energy Processing for the Smart Grid gives an introduction to the energy processing concepts/topics needed by students in electrical engineering or non-electrical engineering who need to work in areas of future grid development. It covers such modern topics as renewable energy, storage technologies, inverter and converter, power electronics, and metering and control for microgrid systems. In addition, this text: Provides the interface between the

classical machines courses with current trends in energy processing and smart grid Details an understanding of three-phase networks, which is needed to determine voltages, currents, and power from source to sink under different load models and network configurations Introduces different energy sources including renewable and non-renewable energy resources with appropriate modeling characteristics and performance measures Covers the conversion and processing of these resources to meet different DC and AC load requirements Provides an overview and a case study of how multiple sources and loads are connected via power electronic devices Benefits most policy makers, students and manufacturing and practicing engineers, given the new trends in energy revolution and the desire to reduce carbon output Energy Processing for the Smart Grid is a helpful text for undergraduates and first year graduate students in a typical engineering program who have already taken network analysis and electromagnetic courses. Design and operation of the electric

power grid (EPG) relies heavily on computational models. High-fidelity, full-order models are used to study transient phenomena on only a small part of the network. Reduced-order dynamic and power flow models are used when analysis involving thousands of nodes are required due to the computational demands when simulating large numbers of nodes. The level of complexity of the future EPG will dramatically increase due to large-scale deployment of variable renewable generation, active load and distributed generation resources, adaptive protection and control systems, and price-responsive demand. High-fidelity modeling of this future grid will require significant advances in coupled, multi-scale tools and their use on high performance computing (HPC) platforms. This LDRD report demonstrates SNL's capability to apply HPC resources to these 3 tasks: (1) High-fidelity, large-scale modeling of power system dynamics; (2) Statistical assessment of grid security via Monte-Carlo simulations of cyber attacks; and (3) Development of models to predict

variability of solar resources at locations where little or no ground-based measurements are available.
Hearings Before a Subcommittee of the Committee on Appropriations, House of Representatives, One Hundred Twelfth Congress, Second Session
Catalog of Federal Domestic Assistance
How Technology Can Revolutionize Efficiency and Renewable Solutions : Hearing Before the Select Committee on Energy Independence and Global Warming, House of Representatives, One Hundred Eleventh Congress, First Session, February 25, 2009
Smart Grids
Energy and Water Development Appropriations for 2011
Advances in Grid and Pervasive Computing

This book consolidates some of the most promising advanced smart grid functionalities and provides a comprehensive set of guidelines for their implementation/evaluation using DIgSILENT Power Factory. It includes specific aspects of modeling, simulation and analysis, for example wide-area monitoring, visualization and control, dynamic capability rating, real-time load measurement and management, interfaces and co-simulation for modeling and simulation of hybrid systems. It also presents key advanced features of

modeling and automation of calculations using PowerFactory, such as the use of domain-specific (DSL) and DIgSILENT Programming (DPL) languages, and utilizes a variety of methodologies including theoretical explanations, practical examples and guidelines. Providing a concise compilation of significant outcomes by experienced users and developers of this program, it is a valuable resource for postgraduate students and engineers working in power-system operation and planning.
Electricity is the lifeblood of modern society, and for the vast majority of people that electricity is obtained from large, interconnected power grids. However, the grid that was developed in the 20th century, and the incremental improvements made since then, including its underlying analytic foundations, is no longer adequate to completely meet the needs of the 21st century. The next-generation electric grid must be more flexible and resilient. While fossil fuels will have their place for decades to come, the grid of the future will need to accommodate a wider mix of more intermittent generating sources such as wind and distributed solar photovoltaics. Achieving this grid of the future will require effort on several fronts. There is a need for continued shorter-term engineering research and development, building on the existing analytic foundations for the grid. But there is also a need for more fundamental research to expand these analytic foundations. Analytic Research Foundations for the Next-Generation Electric Grid provide guidance on the longer-term critical areas for research in mathematical and computational sciences that is needed for the next-generation grid. It offers recommendations that are designed to help direct future research as the grid evolves and to give the nation's research and development infrastructure the tools it needs to effectively develop, test, and use this research.

Medium Voltage Direct Current Grid is the first comprehensive reference to provide advanced methods and best practices with case studies to Medium Voltage Direct Current Grid (MVDC) for Resilience Operation, Protection and Control. It also provides technical details to tackle emerging challenges, and discuss knowledge and best practices about Modeling and Operation, Energy management of MVDC grid, MVDC Grid Protection, Power quality management of MVDC grid, Power quality analysis and control methods, AC/DC, DC/DC modular power converter, Renewable energy applications and Energy storage technologies. In addition, includes support to end users to integrate their systems to smart grid. Covers advanced methods and global case studies for reference Provides technical details and best practices for the individual modeling and operation of MVDC systems Includes guidance to tackle emerging challenges and support users in integrating their systems to smart grids

Smart Grid Systems

Energy and Water Development Appropriations for 2011, Part 7, 2010, 111-2 Hearings

Computer Safety, Reliability, and Security

Economic Efficiency and Risk Mitigation

New Challenges in Optimizing Energy Grids

6th International Conference, GPC 2011, Oulu, Finland, May 11-13, 2011. Proceedings

This book covers the fundamentals of power electronic converter modeling and control, digital simulation, and experimental studies in the area of renewable energy systems and AC/DC microgrid. Recent advanced control methods for voltage source inverters (VSIs) and the hierarchical controlled islanded microgrid are discussed, including the mathematical modeling, controller synthesis, parameter selection and multi-

scale stability analysis, and consensus-based control strategies for the microgrid and microgrid clusters. The book will be an invaluable technical reference for practicing engineers and researchers working in the areas of renewable energy, power electronics, energy internet, and smart grid. It can also be utilized as reference book for undergraduate and postgraduate students in electrical engineering.

"This book examines both system operation and market operation perspectives, focusing on the interaction between the two. It incorporates up-to-date field experiences, presents challenges, and summarizes the latest theoretical advancements. The book id divided into four parts. The first part deals with the fundamentals of integrated system and market operations, including market power mitigation, market efficiency evaluation, and the implications of operation practices in electricity markets. The second part discusses developing technologies to strengthen the use of the grid in electricity markets. System volatility and economic impact introduced by the intermittency of wind and solar generation are also addressed. The third part focuses on stochastic applications, exploring new approaches of handling uncertainty in Security Constrained Unit Commitment (SCUC), as well as the reserves needed for power system operation. The fourth part presents ongoing efforts of utilizing transmission facilities to improve market efficiency, via transmission topology control, transmission switching, transmission outage scheduling, and advanced transmission technologies. [...]" (source : 4ème de couverture).

Americans' safety, productivity, comfort, and convenience depend on the reliable supply of electric power. The electric power system is a complex "cyber-physical" system composed

of a network of millions of components spread out across the continent. These components are owned, operated, and regulated by thousands of different entities. Power system operators work hard to assure safe and reliable service, but large outages occasionally happen. Given the nature of the system, there is simply no way that outages can be completely avoided, no matter how much time and money is devoted to such an effort. The system's reliability and resilience can be improved but never made perfect. Thus, system owners, operators, and regulators must prioritize their investments based on potential benefits. Enhancing the Resilience of the Nation's Electricity System focuses on identifying, developing, and implementing strategies to increase the power system's resilience in the face of events that can cause large-area, long-duration outages: blackouts that extend over multiple service areas and last several days or longer. Resilience is not just about lessening the likelihood that these outages will occur. It is also about limiting the scope and impact of outages when they do occur, restoring power rapidly afterwards, and learning from these experiences to better deal with events in the future.

Wind Farm Advanced Modeling and Control for Smart-grid Support

Energy and Water Development Appropriations for 2013: Dept. of Energy FY 2013 justifications

Modeling and Control of Power Electronic Converters for Microgrid Applications

Get Smart on the Smart Grid

Proceedings of a Workshop

Energy and Water Development Appropriations for 2013: Witnesses

Critical Infrastructures are formed by a large

number of components that interact within complex networks. As a rule, infrastructures contain strong feedbacks either explicitly through the action of hardware/software control, or implicitly through the action/reaction of people. Individual infrastructures influence others and grow, adapt, and thus evolve in response to their multifaceted physical, economic, cultural, and political environments. Simply put, critical infrastructures are complex adaptive systems. In the Advanced Modeling and Techniques Investigations (AMTI) subgroup of the National Infrastructure Simulation and Analysis Center (NISAC), we are studying infrastructures as complex adaptive systems. In one of AMTI's efforts, we are focusing on cascading failure as can occur with devastating results within and between infrastructures. Over the past year we have synthesized and extended the large variety of abstract cascade models developed in the field of complexity science and have started to apply them to specific infrastructures that might experience cascading failure. In this report we introduce our comprehensive model, Polynet, which simulates cascading failure over a wide range of network topologies, interaction rules, and adaptive

responses as well as multiple interacting and growing networks. We first demonstrate Polynet for the classical Bac, Tang, and Wiesenfeld or BTW sand-pile in several network topologies. We then apply Polynet to two very different critical infrastructures: the high voltage electric power transmission system which relays electricity from generators to groups of distribution-level consumers, and Fedwire which is a Federal Reserve service for sending large-value payments between banks and other large financial institutions. For these two applications, we tailor interaction rules to represent appropriate unit behavior and consider the influence of random transactions within two stylized networks: a regular homogeneous array and a heterogeneous scale-free (fractal) network. For the stylized electric power grid, our initial simulations demonstrate that the addition of geographically unrestricted random transactions can eventually push a grid to cascading failure, thus supporting the hypothesis that actions of unrestrained power markets (without proper security coordination on market actions) can undermine large scale system stability. We also find that network topology greatly

influences system robustness. Homogeneous networks that are 'fish-net' like can withstand many more transaction perturbations before cascading than can scale-free networks. Interestingly, when the homogeneous network finally cascades, it tends to fail in its entirety, while the scale-free tends to compartmentalize failure and thus leads to smaller, more restricted outages. In the case of stylized Fedwire, initial simulations show that as banks adaptively set their individual reserves in response to random transactions, the ratio of the total volume of transactions to individual reserves, or 'turnover ratio', increases with increasing volume. The removal of a bank from interaction within the network then creates a cascade, its speed of propagation increasing as the turnover ratio increases. We also find that propagation is accelerated by patterned transactions (as expected to occur within real markets) and in scale-free networks, by the 'attack' of the most highly connected bank. These results suggest that the time scale for intervention by the Federal Reserve to divert a cascade in Fedwire may be quite short. Ongoing work in our cascade analysis effort is building on both these specific stylized applications to enhance their

fidelity as well as embracing new applications. We are implementing markets and additional network interactions (e.g., social, telecommunication, information gathering, and control) that can impose structured drives (perturbations) comparable to those seen in real systems. Understanding the interaction of multiple networks, their interdependencies, and in particular, the underlying mechanisms for their growth/evolution is paramount. With this understanding, appropriate public policy can be identified to guide the evolution of present infrastructures to withstand the demands and threats of the future. Predictive Modeling for Energy Management and Power Systems Engineering introduces readers to the cutting-edge use of big data and large computational infrastructures in energy demand estimation and power management systems. The book supports engineers and scientists who seek to become familiar with advanced optimization techniques for power systems designs, optimization techniques and algorithms for consumer power management, and potential applications of machine learning and artificial intelligence in this field. The book provides modeling theory in an easy-to-read format,

verified with on-site models and case studies for specific geographic regions and complex consumer markets. Presents advanced optimization techniques to improve existing energy demand system Provides data-analytic models and their practical relevance in proven case studies Explores novel developments in machine-learning and artificial intelligence applied in energy management Provides modeling theory in an easy-to-read format

Modeling spatial and spatio-temporal continuous processes is an important and challenging problem in spatial statistics. Advanced Spatial Modeling with Stochastic Partial Differential Equations Using R and INLA describes in detail the stochastic partial differential equations (SPDE) approach for modeling continuous spatial processes with a Matérn covariance, which has been implemented using the integrated nested Laplace approximation (INLA) in the R-INLA package. Key concepts about modeling spatial processes and the SPDE approach are explained with examples using simulated data and real applications. This book has been authored by leading experts in spatial statistics, including the main developers of the INLA and SPDE methodologies and the R-

INLA package. It also includes a wide range of applications: * Spatial and spatio-temporal models for continuous outcomes * Analysis of spatial and spatio-temporal point patterns * Coregionalization spatial and spatio-temporal models * Measurement error spatial models * Modeling preferential sampling * Spatial and spatio-temporal models with physical barriers * Survival analysis with spatial effects * Dynamic space-time regression * Spatial and spatio-temporal models for extremes * Hurdle models with spatial effects * Penalized Complexity priors for spatial models All the examples in the book are fully reproducible. Further information about this book, as well as the R code and datasets used, is available from the book website at http://www.r-inla.org/spde-book. The tools described in this book will be useful to researchers in many fields such as biostatistics, spatial statistics, environmental sciences, epidemiology, ecology and others. Graduate and Ph.D. students will also find this book and associated files a valuable resource to learn INLA and the SPDE approach for spatial modeling.

26th International Conference, SAFECOMP 2007, Nurmberg, Germany, September 18-21, 2007, Proceedings

Resilient Operation, Control and Protection Grid Connected Converters
Advanced Smart Grid Functionalities Based on PowerFactory
Medium-Voltage Direct Current Grid
"The State of Technological Innovation Related to the Electric Grid"

This book addresses different algorithms and applications based on the theory of multiobjective goal attainment optimization. In detail the authors show as the optimal asset of the energy hubs network which (i) meets the loads, (ii) minimizes the energy costs and (iii) assures a robust and reliable operation of the multicarrier energy network can be formalized by a nonlinear constrained multiobjective optimization problem. Since these design objectives conflict with each other, the solution of such the optimal energy flow problem hasn't got a unique solution and a suitable trade off between the objectives should be identified. A further contribution of the book consists in presenting real-world applications and results of the proposed methodologies developed by the authors in three research projects recently completed and characterized by actual implementation under an overall budget of about 23

million €.

This book constitutes the proceedings of the 6th International Conference, GPC 2011, held in Oulu, Finland in May 2011. The 28 revised full papers were carefully revised and selected from 62 submissions and focus on the topics cloud, cluster, and grid computing; peer-to-peer computing; applications and HCI; modeling and verification; service architectures; middleware; and sensor networks.

This book constitutes the refereed proceedings of the 26th International Conference on Computer Safety, Reliability, and Security, SAFECOMP 2007. The 33 revised full papers and 16 short papers are organized in topical sections on safety cases, impact of security on safety, fault tree analysis, safety analysis, security aspects, verification and validation, platform reliability, reliability evaluation, formal methods, static code analysis, safety-related architectures.

Power Grid Operation in a Market Environment

Grid Computing - GRID 2002

Surface Modeling, Grid Generation, and Related Issues in Computational Fluid Dynamic (CFD) Solutions

Third Conference on Mountain Meteorology

Energy and Water Development Appropriations for 2013 Hearing Before the Committee on Energy and Natural Resources, United States Senate, One Hundred Tenth Congress, Second Session, to Receive Testimony on the U.S. Department of Energy's Budget for Fiscal Year 2009, February 6, 2008

The utilization of sensors, communications, and computer technologies to create greater efficiency in the generation, transmission, distribution, and consumption of electricity will enable better management of the electric power system. As the use of smart grid technologies grows, utilities will be able to automate meter reading and billing and consumers will be more aware of their energy usage and the associated costs. The results will require utilities and their suppliers to develop new business models, strategies, and processes. With an emphasis on reducing costs and improving return on investment (ROI) for utilities, Smart Grids: Clouds, Communications, Open Source, and Automation explores the design and implementation of smart grid technologies, considering the benefits to consumers as well as businesses. Focusing on industrial applications, the text: Provides a state-of-the-art account of the smart grid Explains how smart grid technologies are currently being used Includes detailed examples and test cases for real-life implementation Discusses trade-offs associated with the utilization of smart grid technologies Describes smart grid simulation software and offers insight into the future of the smart grid The electric power grid is in the early stages of a sea of change. Nobody knows which business models will survive, but companies heeding the lessons found in Smart Grids: Clouds, Communications, Open Source, and Automation might just

increase their chances for success.

Identifies and describes specific government assistance opportunities such as loans, grants, counseling, and procurement contracts available under many agencies and programs.

The growth of the Internet and the availability of powerful computers and hi- speed networks as low-cost commodity components are changing the way we do computing. These new technologies have enabled the clustering of a wide variety of geographically distributed resources, such as supercomputers, storage systems, data sources, and special devices and services, which can then be used as a uni?ed resource. Furthermore, they have enabled seamless access to and interaction among these distributed resources, services, applications, and data. The new paradigm that has evolved is popularly termed "Grid computing". Grid computing and the utilization of the global Grid infrastructure have presented signi?cant challenges at all levels, including application development, progr- ming models, systems, infrastructures and services, networking, and security, and have led to the development of a global research community. Grid 2002 is the third in a series of workshops developed to provide a - rum for this growing Grid Computing research community. Grid 2000, the ?rst workshop in the series, was chaired by Rajkumar Buyya and Mark Baker, and was held in conjunction with HiPC 2002 in Bangalore, India. Grid 2001 (Chair: Craig A. Lee) and Grid 2002 were held in conjunction with Supercomputing, the world's premier meeting for high-performance computing.

Advanced Simulation for Analysis of Critical Infrastructure

Enhancing the Resilience of the Nation's Electricity System

Hearing Before the Committee on Energy and Natural Resources, United States Senate, One Hundred Fourteenth Congress, First Session ... March 17, 2015

Modeling and Control

Energy and Water Development Appropriations for 2004: Department of Energy fiscal year 2004 budget justifications

New Technologies for Power System Operation and Analysis

Fuzzy logic has vast applications in power and electrical engineering. This collection is the first book to cover research advancements in the application of fuzzy logic in the planning and operation of smart grids. A global group of researchers and scholars present innovative approaches to fuzzy-based smart grid planning and operation, cover theoretical concepts and experimental results of the application of fuzzy-based techniques, and define and apply these techniques to deal with smart grid issues. Applications of Fuzzy Logic in Planning and Operation of Smart Grids is an ideal resource for researchers on the theory and application of fuzzy logic, practicing engineers working in electrical power engineering and power system planning, and post-graduates and students in advanced graduate-level courses.

New Technologies for Power System Operation and Analysis considers the very latest developments in renewable energy integration and system operation, including electricity markets and wide-area monitoring systems and forecasting. Helping readers quickly grasp the essential information needed to address renewable energy integration challenges, this new book looks at basic power system

mathematical models, advanced renewable integration and system optimizations from transmission and distribution system sides. Sections cover wind, solar, gas and petroleum, making this a useful reference for all engineers interested in power system operation. Includes codes in MATLAB® and Python Provides a complete analysis of all new and relevant power system technologies Covers the impact on existing power system operations at the advanced level, with detailed technical insights Advances in Grid-Connected Photovoltaic Power Conversion Systems addresses the technological challenges of fluctuating and unreliable power supply in grid-connected photovoltaic (PV) systems to help students, researchers, and engineers work toward more PV installations in the grid to make society more sustainable and reliable while complying with grid regulations. The authors combine their extensive knowledge and experience in this book to address both the basics of the power electronic converter technology and the advances of such practical electric power conversion systems. This book includes extensive, step-by-step practical application examples to assist students and engineers to better understand the role of power electronics in modern PV applications and solve the practical issues in grid-connected PV systems. Offers a step-by-step modeling approach to solving the practical issues and technological challenges in grid-connected PV

systems Provides practical application examples to assist the reader to better understand the role of power electronics in modern PV applications Extends to the most modern technologies for grid-friendly PV systems

Modeling, Stability and Control

Abstract Cascades, the Electric Power Grid, and Fedwire

Analytic Research Foundations for the Next-Generation Electric Grid

Applications of Fuzzy Logic in Planning and Operation of Smart Grids

From Smart Grids to Smart Cities

Energy and Water Development Appropriations for 2012: Department of Energy

Grid Connected Converters: Modeling, Stability and Control discusses the foundations and core applications of this diverse field, from structure, modeling and dynamic equivalencing through power and microgrids dynamics and stability, before moving on to controller synthesis methodologies for a powerful range of applications. The work opens with physical constraints and engineering aspects of advanced control schemes. Robust and adaptive control strategies are evaluated using real-time simulation and experimental studies. Once foundations have been established, the work goes on to address new technical challenges such as virtual synchronous generators and synergic inertia emulation in response to low inertia challenges in modern power

grids. The book also addresses advanced systematic control synthesis methodologies to enhance system stability and dynamic performance in the presence of uncertainties, practical constraints and cyberattacks. Addresses new approaches for modeling, stability analysis and control design of GCCs Proposes robust and flexible GCC control frameworks for supporting grid regulation Emphasizes the application of GCCs in inertia emulation, oscillation damping control, and dynamic shaping Addresses systematic control synthesis methodologies for system security and dynamic performance

Energy Processing and Smart Grid

Final Report for %22High Performance Computing for Advanced National Electric Power Grid Modeling and Integration of Solar Generation Resources%22, LDRD Project

Predictive Modelling for Energy Management and Power Systems Engineering

Unstructured Grid Generation Techniques and Software

Clouds, Communications, Open Source, and Automation

Energy and Water Development Appropriations for 2011: Dept. of Energy: Environmental management and legacy management; energy efficiency and renewable energy ... science and ARPA-E