Battery Management Systems For Large Lithium Ion Battery Packs

Addresses the methodology and theoretical foundation of battery manufacturing, service and management systems (BM2S2), and discusses the issues and challenges in these areas. This book brings together experts in the field to highlight the cutting edge research advances in BM2S2 and to promote an innovative integrated research framework responding to the challenges. There are three major parts included in this book: manufacturing, service, and management. The first part focuses on battery manufacturing systems, including modeling, analysis, design and control, as well as economic and risk analyses. The second part focuses on information technology’s impact on service systems, such as data-driven reliability modeling, failure prognosis, and service decision making methodologies for battery services. The third part addresses battery management systems (BMS) for control and optimization of battery cells, operations, and hybrid storage systems to ensure overall performance and safety, as well as EV management. The contributors consist of experts from universities, industry research centers, and government agency. In addition, this book: Provides comprehensive overviews of lithium-ion battery and battery electrical vehicle manufacturing, as well as economic returns and government support. Introduces integrated models for quality propagation and productivity improvement, as well as indicators for bottleneck identification and mitigation in battery manufacturing. Covers models and diagnosis algorithms for battery SOC and SOH estimation, data-driven prognosis algorithms for predicting the remaining useful life (RUL) of battery SOC and SOH. Presents mathematical models and novel structure of battery equalizers in battery management systems (BMS). Reviews the state of the art of battery, supercapacitor, and battery-supercapacitor hybrid energy storage systems (HESSs) for advanced electric vehicle applications. Advances in Battery Manufacturing, Services, and Management Systems is written for researchers and engineers working on battery manufacturing, service, operations, logistics, and management. It can also serve as a reference for senior undergraduate and graduate students interested in BM2S2. The advent of lithium-ion batteries has brought a significant shift in the area of large format battery systems. Previously limited to heavy and bulky lead-acid storage batteries, large format batteries were used only where absolutely necessary as a means of energy storage. The improved energy density, cycle life, power capability, and durability of lithium-ion cells has given us electric and hybrid vehicles with meaningful driving range and performance, grid-tied energy storage systems for integration of renewable energy and load leveling, backup power systems and other applications. This book discusses battery management systems (BMS) technology for large format lithium-ion battery packs from a systems perspective. This resource covers the future of BMS, giving us new ways to generate, use, and store energy, and free us from the perils of non-renewable energy sources. This book provides a full update on BMS technology, covering software, hardware, integration, testing, and safety. This book describes the field of State-of-Charge (SoC) indication for rechargeable batteries. An overview of the state-of-the-art of SoC indication methods including available market solutions from leading semiconductor companies is provided. All disciplines are covered, from electrical, chemical, mathematical and measurement engineering to understanding battery behavior. This book will therefore be of interest to engineers and involved in battery management. In the last few decades, electric drives have found their place in a considerable number of diverse applications. They are successfully replacing some other traditional types of drives owing to their better performance and excellent controllability. The introduction of electric drives is in most cases also beneficial from the ecological point of view as they are not directly dependent on fossil fuels and an increasing part of electric energy they consume is generated in renewable energy sources. This book focuses on applications of electric drives that emerged only recently and/or novel aspects that appear in them. Particular attention is given to using electric drives in vehicles, aircraft, non-road mobile machinery, and HVAC systems. Thermal Management of Electric Vehicle Battery Systems provides a thorough examination of various conventional and cutting edge electric vehicle (EV) battery thermal management systems (including phase change material) that are currently used in the industry as well as being proposed for future EV batteries. It covers how to select the right thermal management design, configuration and parameters for the users’ battery chemistry, applications and operating conditions, and provides guidance on the setup, instrumentation and operation of their thermal management systems (TMS) in the most efficient and effective manner. This book provides the reader with the necessary information to develop a capable battery TMS that can keep the cells operating within the ideal operating temperature ranges and uniformities, while minimizing the associated energy consumption, cost and environmental impact. The procedures used are explained step-by-step, and generic and widely used parameters are utilized as much as possible to enable the reader to incorporate the conducted analyses to the systems they are working on. Also included are comprehensive thermodynamic modelling and analyses of TMSs as well as databanks of component costs and environmental impacts, which can be useful for providing new ideas on improving vehicle designs. Key features: Discusses traditional and cutting edge technologies as well as research directions. Covers thermal management systems and their selection for different vehicles and applications. Includes case studies and practical examples from the industry. Covers thermodynamic analyses and assessment methods, including those based on energy and exergy, as well as exergoeconomic, exergoenvironmental and enviroeconomic techniques. Accompanied by a website hosting codes, models, and economic and environmental databases as well as various related information. This book describes the field of State-of-Charge (SoC) indication for rechargeable batteries. An overview of the state-of-the-art of SoC indication methods including available market solutions from leading semiconductor companies is provided. All disciplines are covered, from electrical, chemical, mathematical and measurement engineering to understanding battery behavior. This book will therefore be of interest to engineers and involved in battery management. Hannes Hopp erläutert die Notwendigkeit zur Kühlung von Lithium-Ionen-Batterien im Fahrzeug und stellt eine simulative Methode zur Prognose von Batterietemperaturen und der Wechselwirkung mit dem Kühlsystem im Fahrzeug verbundvor. Im Simulationsverbund bildet das Batteriemodell die zentrale Komponente. Aufbauend auf bestehenden Modellierungsansätzen untersucht der Autor die Abwärmecharakteristik der Batterie aus Einzelmessungen und überführt sie in ein modulares Simulationsmodell. Die Ergebnisse seiner Studie unterstreichen die Notwendigkeit zur engen Verzahnung von simulativen und experimentellen Werkzeugen in der Fahrzeugentwicklung. Die gekoppelte Simulation stellt eine zielführende Methode zur Bewertung der thermischen und elektrischen Interaktion in einem elektromobilen Fahrzeug dar. This second volume discusses state-of-the-art applications of equivalent-circuit models as they pertain to solving problems in battery management and control. Readers are provided
information on how to use models from Volume I to control battery packs, along with discussion of fundamental flaws in current approaches. In addition, Volume II introduces the ideas of physics-based optimal battery controls and explains why they can be superior to the state-of-the-art equivalent-circuit controls. This book systematically introduces readers to the core algorithms of battery management system (BMS) for electric vehicles. These algorithms cover most of the technical bottlenecks encountered in BMS applications, including battery system modeling, state of charge (SOC) and state of health (SOH) estimation, state of power (SOP) estimation, remaining useful life (RUL) prediction, heating at low temperature, and optimization of charging. The book not only presents these algorithms, but also discusses their background, as well as related experimental and hardware developments. The concise figures and program codes provided make the calculation process easy to follow and apply, while the results obtained are presented in a comparative way, allowing readers to intuitively grasp the characteristics of different algorithms. Given its scope, the book is intended for researchers, senior undergraduate and graduate students, as well as engineers in the fields of electric vehicles and energy storage. This book presents the results of discussions and presentation from the latest ISDT event (2014) which was dedicated to the 94th birthday anniversary of Prof. Lotfi A. Zade, father of Fuzzy logic. The book consists of three main chapters, namely: Chapter 1: Integrated Systems Design Chapter 2: Knowledge, Competence and Business Process Management Chapter 3: Integrated Systems Technologies Each article presents novel and scientific research results with respect to the target goal of improving our common understanding of KT integration. This comprehensive, two-volume resource provides a thorough introduction to lithium ion (Li-ion) technology. Readers get a hands-on understanding of Li-ion technology, are guided through the design and assembly of a battery, through deployment, configuration and testing. The book covers dozens of applications, with solutions for each application provided. Volume One focuses on the Li-ion cell and its types, formats, and chemistries. Cell arrangements and issues, including series (balance) and parallel (fusing, inrush current) are also discussed. Li-ion Battery Management Systems are explored, focusing on types and topologies, functions, and selection. Battery design, assembly, deployment, troubleshooting and repair are also discussed, along with modular batteries, split batteries and battery arrays. Written by a prominent expert in the field and packed with over 500 illustrations, these volumes contain solutions to practical problems, making it useful for both the novice and experienced practitioners. This Special Edition of Energies on “Energy Storage and Management for Electric Vehicles” draws together a collection of research papers that critically evaluates key areas of innovation and novelty when designing and managing the high-voltage battery system within an electrified powertrain. The addressed topics include design optimisation, mathematical modelling, control engineering, thermal management, and component sizing. The future of electric vehicles relies entirely on the design, monitoring, and control of the vehicle battery and its associated systems. Along with an initial optimal design of the cell/pack-level structure, the runtime performance of the battery needs to be continuously monitored and optimized for a safe and reliable operation and prolonged life. Improved charging techniques need to be developed to protect and preserve the battery. The scope of this Special Issue is to address all the above issues by promoting innovative design concepts, modeling and state estimation techniques, charging/discharging management, and hybridization with other storage components. Safety of Lithium Batteries describes how best to assure safety during all phases of the life of Lithium ion batteries (production, transport, use, and disposal). About 5 billion Li-ion cells are produced each year, predominantly for use in consumer electronics. This book describes how the high-energy density and outstanding performance of Li-ion batteries will result in a large increase in the production of Li-ion cells for electric drive train vehicle (xEV) and battery energy storage (BES or EES) purposes. The high-energy density of Li battery systems comes with special hazards related to the materials employed in these systems. The manufacturers of cells and batteries have strongly reduced the hazard probability by a number of measures. However, absolute safety of the Li system is not given as multiple incidents in consumer electronics have shown. Presents the relationship between chemical and structure material properties and cell safety Relates cell and battery design to safety as well as system operation parameters to safety Outlines the influences of abuses on safety and the relationship to battery testing Explores the limitations for transport and storage of cells and batteries Includes recycling, disposal and second use of lithium ion batteries This contributed volume contains the results of the research program “Agreement for Hybrid and Electric Vehicles”, developed in the framework of the Energy Technology Network of the International Energy Agency. The topical focus lies on technology options for the system optimization of hybrid and electric vehicle components and drive train configurations which enhance the energy efficiency of the vehicle. The approach to the topic is genuinely interdisciplinary, covering insights from fields. The target audience primarily comprises researchers and industry experts in the field of automotive engineering, but the book may also be beneficial for graduate students. This timely book provides you with a solid understanding of battery management systems (BMS) in large Li-Ion battery packs, describing the important technical challenges in this field and exploring the most effective solutions. You find in-depth discussions on BMS topologies, functions, and complexities, helping you determine which permutation is right for your application. Packed with numerous graphics, tables, and images, the book explains the OC whysOCO and OC howsOCO of Li-Ion BMS design, installation, configuration and troubleshooting. This hands-on resource includes an unbiased description and comparison of all the off-the-shelf Li-Ion BMSSs available today. Moreover, it explains how using the correct one for a given application can help to get a Li-Ion pack up and running in little time at low cost. Collection of selected, peer reviewed papers from the 2013 3rd International Conference on Mechanical Engineering, Industry and Manufacturing Engineering (MEIME2013), June 22-23, Wuhan, China. Volume is indexed by Thomson Reuters CPCI-S (WoS). The 130 papers are grouped as follows: Chapter 1: Mechanical Engineering and Mechanics, Control Technologies in Manufacture and Industry; Chapter 2: Material Engineering and Processing, Applied Mechanics and Theoretical Computer Methods in Materials; Chapter 3: Industry Technologies and Application; Chapter 4: Manufacturing Engineering and Manufacture Automation. This research presents a method for efficiently and reproducibly comparing diverse battery thermal management concepts in an early stage of development to assist in battery system design. The basis of this method is a hardware-based thermal simulation model of a prismatic Lithium-Ion battery, called the Smart Battery Cell (SBC). By eliminating the active chemistry, enhanced reproducibility of the experimental boundary conditions and increased efficiency of the experimental trials are realized. Additionally, safety risks associated with Lithium-Ion cells are eliminated, making the use of the SBC possible with thermal
management systems in an early state of developed and without costly safety infrastructure. The integration of thermocouples leaves the thermal contact surface undisturbed, allowing the SBC to be integrated into diverse thermal management systems.

Climate change has become one of the most important global challenges that both developing and developed nations face in the 21st Century. In the transportation sector, electric vehicles (xEV) have emerged as a viable solution to fight climate change. However, the short longevity of the battery system, and their limited range which depends on the battery performance, remains a drawback. In the electric power sector, renewable energy (solar and wind) have emerged as a strong alternative, but these sources are intermittent and cause fluctuations on the electrical power grid. To solve these issues, renewable energy systems are sometimes coupled with a battery energy storage system (BESS). Most of these large BESS consist of lithium ion batteries because they are becoming more cost effective than other types. However, there is an issue with both of these applications: as the battery ages, the performance of the battery pack is limited because large variations develop between the large number of series connected cells. This requires the use of an electronic equalizer (EQ) to balance the cell voltages. Currently there are two types of equalizers: passive and active. The passive EQU monitors the weakest cell (lowest voltage), and removes charge from the other cells by dissipating their energy as heat through shunt resistors until all cells voltages equal the weakest cell. This leads to energy loss (heating), reduced capacity, and poor performance. In spite of this, the vast majority of users prefer to use passive EQUs because they are cheap. The second type is called an active EQU, and it transfers charge from one cell to another to balance the cell voltages. This results in reduced energy loss, increased capacity, and higher performance for the battery pack. Although active EQUs have high performance, they remain expensive, costing about 10x the cost of a passive EQU. As a result, very few users use active equalizers. This research proposes a solution that has high performance close to an active EQU but at a low cost like the passive EQU. This solution is the Bilevel Equalizer (BEQ), which is a unique hybrid because it consists of both an active (AEQ) and a passive (PEQ) EQU. Current battery management systems (BMS) use either a passive EQU or an active EQU, but they do not use both. The term bilevel is used because the BEQ balances the cell voltages at two different levels. A large Li-ion battery consists of a large number of cells, as many as 18650 series connected cells, in series, the BEQ continues to balance them. A small battery consists of a small number of series connected cells, in which the BEQ also continues to balance. The voltages of the 6 cells in each section are balanced by a PEQ, for that section, and the 16 section voltages are balanced by an AEQ. As a result, a weak cell in a section only drags down the other cells within that section, instead of all cells in the battery pack. The AEQ then transfers charge to the weakest section from the other sections. As a result, the battery capacity is increased to a level close to that for a pure AEQ. The BEQ has a lower cost than the AEQ because of the number of lower number of active EQU units, e.g., 15 for the BEQ (number of sections -1) vs. 96 for an AEQ in the previous 96 cell example. The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Component levels, Types and Terminology offers to the reader a clear and concise explanation of how Li-ion batteries are designed from the perspective of a manager, sales person, product manager or entry level engineer who is not already an expert in Li-ion battery design. It will offer a layman’s explanation of the history of vehicle electrification, what the various terminology means, and how to do some simple calculations that can be used in determining basic battery sizing, capacity, voltage and energy. By the end of this book the reader has a solid understanding of all of the terminology around Li-ion batteries and is able to do some simple battery calculations. The book is immensely useful to beginners and experienced engineer alike who are moving into the battery field. Li-ion batteries are one of the most unique systems in automobiles today in that they combine multiple engineering disciplines, yet most engineering programs focus on only a single engineering field. This book provides you with a reference to the history, terminology and design criteria needed to understand the Li-ion battery and to successfully layout a new battery concept. Whether you are an electrical engineer, a mechanical engineer or a chemist this book helps you better appreciate the inter-relationships between the various battery engineering fields that are required to understand the battery as an Energy Storage System. Offers an easy explanation of battery terminology and enables better understanding of batteries, their components and the market place. Demonstrates simple battery scaling calculations in an easy to understand description of the formulas Describes clearly the various components of a Li-ion battery and their importance Explains the differences between various Li-ion cell types and chemistries and enables the determination which chemistry and cell type is appropriate for which application Outlines the differences between battery types, e.g., power vs energy battery Presents graphically different vehicle configurations: BEV, PHEV, HEV Includes brief history of vehicle electrification and its future. Because of their advantages of no memory effect, relatively long lifetime, and high energy density, lithium ion batteries have now become one of the most popular rechargeable batteries. However, there are some limitations on the usage of these batteries such as low temperature tolerance, potential danger of overcharge, and potential damage of over discharge. Therefore, a battery management system (BMS) is required to guarantee the maximum performance and safety. A traditional battery management system (BMS) for lithium ion batteries can take measurements and turn the system on and off based on the measurement results. This type of BMS also always has an equalization method for balancing the voltages of the series connected cells. However, these standard functions are not sufficient for modern lithium ion battery applications. The smart BMS is an updated system that inherits the functions of a traditional BMS, and adds new features to meet additional requirements. This BMS is able to store and analyze the measurement data in order to detect defective cells. This is necessary to provide maintenance or replacement before these cells influence the performance of the whole battery pack. The smart BMS is also able to enhance the safety of the battery by reducing the measurement and communication time intervals, and a study of these new features also has been conducted. In addition, the smart BMS also has some optimization features such as higher measurement accuracy, EMI reduction, a user friendly GUI, and state of charge (SOC) and state of health (SOH) determination. Some comparisons also have been made with similar BMS products currently available in the market in order to demonstrate the special advantages of the smart BMS. Durch die Elektrifizierung des Antriebsstrangs sind die Automobilhersteller gezwungen, ihr Produktionssystem anzupassen. Die Entscheidung über die Fertigungstiefe ist sowohl durch Nachfrage- und Technologieunsicherheit als auch durch die Möglichkeit einer dynamischen Anpassung der Strategie gekennzeichnet. Christian Huth entwickelt einen Planungsansatz, welcher diese Aspekte berücksichtigt und auf Basis einer Simulation die finanziellen Implikationen unterschiedlicher Fertigungstiefe-strategien bewertet. 2 Microgrid technology is an emerging area, and it has numerous advantages over the conventional power grid. A microgrid is defined as Distributed Energy Resources (DER) and interconnected loads with clearly defined electrical boundaries that act as a single controllable entity concerning the grid. Microgrid technology enables the connection and disconnection of the system from the grid. That is, the microgrid can operate both in grid-connected and islanded modes of operation. Microgrid technologies are an important part of the evolving landscape of energy and power systems. Many aspects of microgrids are discussed in this volume, including, in the early chapters of the book, the various types of energy storage systems, power and energy management for microgrids, power electronics interface for AC & DC microgrids, battery management systems for microgrid applications, power system analysis for microgrids, and many others. The middle section of the book presents the power quality problems in microgrid systems and its mitigations, gives an overview of various power quality problems and its solutions, describes the PSO algorithm based UPQC controller for power quality enhancement, describes the power quality enhancement and grid support through a solar energy conversion system, presents the fuzzy logic-based power quality assessments, and covers various power quality indices. The final chapters in the book present the recent advancements in the microgrids, applications of Internet of Things (IoT) for microgrids, the application of artificial intelligent techniques, modeling of green energy smart meter for microgrids, communication networks for microgrids, and other aspects of microgrid technologies. Valuable as a learning tool for beginners in this area as well as a daily reference for engineers and
scientists working in the area of microgrids, this is a must-have for any library.

A guide on how to convert any gas- or diesel-powered vehicle to electric power. Includes ownership advantages, basic EV operation, subsystems, components, basic EV operation, project vehicles, and conversion kits.

This book constitutes the proceedings of the 33rd International Conference on Architecture of Computing Systems, ARCS 2020, held in Aachen, Germany, in May 2020. The 12 full papers in this volume were carefully reviewed and selected from 33 submissions. 6 workshop papers are also included. ARCS has always been a conference attracting leading-edge research outcomes in Computer Architecture and Operating Systems, including a wide spectrum of topics ranging from embedded and real-time systems all the way to large-scale and parallel systems. The selected papers focus on concepts and tools for incorporating self-adaptation and self-organization mechanisms in high-performance computing systems. This includes upcoming approaches for runtime modifications at various abstraction levels, ranging from hardware changes to goal changes and their impact on architectures, technologies, and languages. The conference was canceled due to the COVID-19 pandemic.

Battery Management Systems - Design by Modelling describes the design of Battery Management Systems (BMS) with the aid of simulation methods. The basic tasks of BMS are to ensure optimum use of the energy stored in the battery (pack) that powers a portable device and to prevent damage inflicted on the battery (pack). This becomes increasingly important due to the larger power consumption associated with added features to portable devices on the one hand and the demand for longer run times on the other hand. In addition to explaining the general principles of BMS tasks such as charging algorithms and State-of-Charge (SoC) indication methods, the book also covers real-life examples of BMS functionality of practical portable devices such as shavers and cellular phones. Simulations offer the advantage over measurements that less time is needed to gain knowledge of a battery's behaviour in interaction with other parts in a portable device under a wide variety of conditions. This knowledge can be used to improve the design of a BMS, even before a prototype of the portable device has been built. The battery is the central part of a BMS and good simulation models that can be used to improve the BMS design were previously unavailable. Therefore, a large part of the book is devoted to the construction of simulation models for rechargeable batteries. With the aid of several illustrations it is shown that design improvements can indeed be realized with the presented battery models. Examples include an improved charging algorithm that was elaborated in simulations and verified in practice and a new SoC indication system that was developed showing promising results. The contents of Battery Management Systems - Design by Modelling is based on years of research performed at the Philips Research Laboratories. The combination of basic and detailed descriptions of battery behaviour both in chemical and electrical terms makes this book truly multidisciplinary. It can therefore be read both by people with an (electro)chemical and an electrical engineering background.

While this design has many great features, lack of full software support makes many of the subsystems dependent on user interaction to use. As a result, the design is not fully complete. Additionally, last minute design changes on the final revision resulted in detrimental effects to the accuracy of many of the analog circuits including the current sensing features.

A comprehensive examination of advanced battery management technologies and practices in modern electric vehicles Policies surrounding energy sustainability and environmental impact have become of increasing interest to governments, industries, and the general public worldwide. Policies embracing strategies that reduce fossil fuel dependency and greenhouse gas emissions have driven the widespread adoption of electric vehicles (EVs), including hybrid electric vehicles (HEVs), pure electric vehicles (PEVs) and plug-in electric vehicles (PHEVs). Battery management systems (BMSs) are crucial components of such vehicles, protecting a battery system from operating outside its Safe Operating Area (SOA), monitoring its working conditions, calculating and reporting its states, and charging and balancing the battery system. Advanced Battery Management Technologies for Electric Vehicles is a compilation of contemporary model-based state estimation methods and battery charging and balancing techniques, providing readers with practical knowledge of both fundamental concepts and practical applications. This timely and highly-relevant text covers essential areas such as battery modeling and battery state of charge, energy, health and power estimation methods. Clear and accurate background information, relevant case studies, chapter summaries, and reference citations help readers to fully comprehend each topic in a practical context. Offers up-to-date coverage of modern battery management technology and practice Provides case studies of real-world engineering applications Guides readers from electric vehicle fundamentals to advanced battery management topics Includes chapter introductions and summaries, case studies, and color charts, graphs, and illustrations Suitable for advanced undergraduate and graduate coursework, Advanced Battery Management Technologies for Electric Vehicles is equally valuable as a reference for professional researchers and engineers.

Grid-Scale Energy Storage Systems and Applications provides a timely introduction to state-of-the-art technologies and important demonstration projects in this rapidly developing field. Written with a view to real-world applications, the authors describe storage technologies and then cover operation and control, system integration and battery management, and other topics important in the design of these storage systems. The rapidly-developing area of electrochemical energy storage technology and its implementation in the power grid is covered in particular detail. Examples of Chinese pilot projects in new energy grids and microgrids are also included. Drawing on significant Chinese results in this area, but also including data from abroad, this will be a valuable reference on the development of grid-scale energy storage for engineers and scientists in power and energy transmission and researchers in academia. Addresses not only the available energy storage technologies, but also topics significant for storage system
designers, such as technology management, operation and control, system integration and economic assessment. Draws on the wealth of Chinese research into energy storage and describes important Chinese energy storage demonstration projects. Provides practical examples of the application of energy storage technologies that can be used by engineers as references when designing new systems.

This new resource provides you with an introduction to battery design and test considerations for large-scale automotive, aerospace, and grid applications. It details the logistics of designing a professional, large, Lithium-ion battery pack, primarily for the automotive industry, but also for non-automotive applications. Topics such as thermal management for such high-energy and high-power units are covered extensively, including detailed design examples. Every aspect of battery design and analysis is presented from a hands-on perspective. The authors work extensively with engineers in the field and this book is a direct response to frequently-received queries. With the authors' unique expertise in areas such as battery thermal evaluation and design, physics-based modeling, and life and reliability assessment and prediction, this book is sure to provide you with essential, practical information on understanding, designing, and building large format Lithium-ion battery management systems.

The topics of interest in this book include significant challenges in the BMS design of EV/HEV. The equivalent models developed for several types of integrated Li-ion batteries consider the environmental temperature and ageing effects. Different current profiles for testing the robustness of the Kalman filter type estimators of the battery state of charge are used in this book. Additionally, the BMS can integrate a real-time model-based sensor Fault Detection and Isolation (FDI) scheme for a Li-ion cell undergoing degradation, which uses the recursive least squares (RLS) method to estimate the equivalent circuit model (ECM) parameters. This book will fully meet the demands of a large community of readers and specialists working in the field due to its attractiveness and scientific content with a great openness to the side of practical applicability. This covers various interesting aspects, especially related to the characterization of commercial batteries, diagnosis and optimization of their performance, experimental testing and statistical analysis, thermal modelling, and implementation of the most suitable Kalman filter type estimators of high accuracy to estimate the state of charge.

Due to the increasing world population, energy consumption is steadily climbing, and there is a demand to provide solutions for sustainable and renewable energy production, such as wind turbines and photovoltaics. Power electronics are being used to interface renewable sources in order to maximize the energy yield, as well as smoothly integrate them within the grid. In many cases, power electronics are able to ensure a large amount of energy saving in pumps, compressors, and ventilation systems. This book explains the operations behind different renewable generation technologies in order to better prepare the reader for practical applications. Multiple chapters are included on the state-of-the-art and possible technology developments within the next 15 years. The book provides a comprehensive overview of the current renewable energy technology in terms of system configuration, power circuit usage, and control. It contains two design examples for small wind turbine system and PV power system, respectively, which are useful for real-life installation, as well as many computer simulation models.

The editors of this Special Issue titled “Intelligent Control in Energy Systems” have attempted to create a book containing original technical articles addressing various elements of intelligent control in energy systems. In response to our call for papers, we received 60 submissions. Of those submissions, 27 were published and 33 were rejected. In this book, we offer the 27 accepted technical articles as well as one editorial. Authors from 15 countries (China, Netherlands, Spain, Tunisia, United States of America, Korea, Brazil, Egypt, Denmark, Indonesia, Oman, Canada, Algeria, Mexico, and the Czech Republic) elaborate on several aspects of intelligent control in energy systems. The book covers a broad range of topics including fuzzy PID in automotive fuel cell and MPPT tracking, neural networks for fuel cell control and dynamic optimization of energy management, adaptive control on power systems, hierarchical Petri Nets in microgrid management, model predictive control for electric vehicle battery and frequency regulation in HVAC systems, deep learning for power consumption forecasting, decision trees for wind systems, risk analysis for demand side management, finite state automata for HVAC control, robust Kalman filter type estimators of high accuracy to estimate the state of charge, and describes the commonly used equivalent-circuit type battery model and develops equations for superior physics-based models of lithium-ion cells at different length scales. This resource also presents a breakthrough technology called the “discrete-time realization algorithm” that automatically converts physics-based models into high-fidelity approximate reduced-order models.

Written by a leading expert in the field, this practical book offers a comprehensive understanding of the impact of extreme weather and the possible effects of climate change on the power grid. The impact and restoration of floods, winter storms, wind storms, and hurricanes as well as the effects of heat waves and dry spells on thermal power plants is explained in detail. This book explores proven practices for successful restoration of the power grid, increased system resiliency, and ride-through after extreme weather and provides readers with examples from super storm Sandy. This book presents the effects of lack of ground moisture on transmission line performance and gives an overview of line insulation coordination, stress-strength analysis, and tower insulation strength, and then provides readers with tangible solutions. Structural hardening of power systems against storms, including wind pressure, wood poles, and vegetation management is covered. Moreover, this book provides suggestions for practical implementations to improve future smart grid resiliency.

The ambitious objectives of future road mobility, i.e. fuel efficiency, reduced emissions, and zero accidents, imply a paradigm shift in the concept of the car regarding its architecture, materials, and propulsion technology, and require an intelligent integration into the systems of transportation and power. ICT, components and smart systems have been essential for a multitude of recent innovations, and are
expected to be key enabling technologies for the changes ahead, both inside the vehicle and at its interfaces for the exchange of data and power with the outside world. It has been the objective of the International Forum on Advanced Microsystems for Automotive Applications (AMAA) for almost two decades to detect novel trends and to discuss technological implications and innovation potential from day one on. In 2012, the topic of the AMAA conference is “Smart Systems for Safe, Sustainable and Networked Vehicles”. The conference papers selected for this book address current research, developments and innovations in the field of ICT, components and systems and other key enabling technologies leading to the automobile and road transport of the future. The book focuses on application fields such as electrification, power train and vehicle efficiency, safety and driver assistance, networked vehicles, as well as components and systems. Additional information is available at www.amaa.de