

Innovation For Sustainable Electricity Systems

No progress towards sustainable development is possible without the participation of informed and aware citizens and decision-makers. This book examines a dynamic sector – energy - and a space – city - that are critical for sustainability. Urban energy systems are capital intensive and have long lives. Immediate change is difficult, but innovation is crucial for progress toward more intelligent systems. Here is an informative guide for decision makers and citizens alike. This book gathers the latest advances, innovations, and applications in the field of sustainable energy systems, as presented by researchers and engineers at the International Conference Sustainable Energy Systems: Innovative Perspectives (SES), held in Saint-Petersburg, Russia, on October 29-30, 2020. It covers highly diverse topics, including applications of renewable energy sources, recycling of solid municipal and industrial waste, circular economy based on agricultural waste, energy-efficient and sustainable buildings, innovation management and technologies of sustainable cities, sustainable construction, creative construction technology and materials, construction simulation and virtual construction, BIM and rapid prototyping for construction, consumption practices in the digital era, sustainable operations management, and supply chain management in the digital era. The contributions, which were selected by means of a rigorous international peer-review process, highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaborations. Continuation along current development pathways is not sustainable. Available technology and production practices and the consumption patterns of modern societies are leading

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to global warming and ecological destruction. Business as usual is not an option. There is an urgent need to find a new development paradigm that ensures environmental sustainability while managing to provide, now and in the future, a decent livelihood for all of humankind. In Technology and Innovation for Sustainable Development, experts in the area provide a variety of insights about the technical transformation needed for sustainable development. It spells out the behavioural and policy changes that would need to accompany the next technological transformation, taking into account the complexity of inducing technological change in the energy and agricultural sectors. The assessment suggests that this will require major, but doable improvements in national innovation systems and major, but affordable shifts in investment patterns and related macroeconomic adjustments.

NREL's sustainability practices are integrated throughout the laboratory and are essential to our mission to develop clean energy and energy efficiency technologies and practices, advance related science and engineering, and provide knowledge and innovations to integrate energy systems at all scales. Sustainability initiatives are integrated through our campus, our staff, and our environment allowing NREL to provide leadership in modeling a sustainability energy future for companies, organizations, governments, and communities.

This volume contains the proceedings of the 11th KES International Conference on Sustainability and Energy in Buildings 2019 (SEB19) held in Budapest, 4th -5th July 2019 organised by KES International in partnership with Cardiff Metropolitan University, Wales, UK. SEB-19 invited contributions on a range of topics related to sustainable buildings and explored innovative themes regarding sustainable energy systems. The aim of the conference was

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to bring together researchers, and government and industry professionals to discuss the future of energy in buildings, neighbourhoods and cities from a theoretical, practical, implementation and simulation perspective. The conference formed an exciting chance to present, interact, and learn about the latest research and practical developments on the subject. The conference attracted submissions from around the world. Submissions for the Full-Paper Track were subjected to a blind peer-review process. Only the best of these were selected for presentation at the conference and publication in these proceedings. It is intended that this volume provides a useful and informative snapshot of recent research developments in the important and vibrant area of Sustainability in Energy and Buildings.

The future of modern societies depends on their ability to deal with the challenge of climate change in the coming decades. One essential component is a better understanding of innovation processes in the energy sector. This book focuses on sustainability innovations in renewable energies, combined heat and power, and energy service contracting, and analyses the institutions, actors and functions within the innovation system. Of particular interest is the question of whether the joint effect of EU-driven market liberalization and climate policies will succeed in establishing market forces that will drive actors towards more climate-friendly energy production. A special focus is on the role of local utilities in the electricity sector as opposed to large transmission net operators or regional net operators. The countries covered in the contributions include Germany, Denmark, the UK, Switzerland, and the Netherlands.

This book contains the proceedings of the 13th KES International Conference on Sustainability and Energy in Buildings 2021 (SEB2021) held in Split, Croatia, during 15–17 September 2021 organized by KES International. SEB21

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This book contains the proceedings of the 12th KES International Conference on Sustainability and Energy in Buildings 2020 (SEB20) held in Split, Croatia, during 24–26 June 2020 organized by KES International. SEB20 invited contributions on a range of topics related to sustainable buildings and explored innovative themes regarding sustainable energy systems. The aim of the conference is to bring together researchers, and government and industry professionals to discuss the future of energy in buildings, neighbourhoods and cities from a theoretical, practical, implementation and simulation perspective. The conference formed an exciting chance to present, interact and learn about the latest research and practical developments on the subject. The conference attracted submissions from around the world. Submissions for the Full-Paper Track were subjected to a blind peer-review process. Only the best of these were selected for presentation at the conference and publication in these proceedings. It is intended that this book provides a useful and informative snapshot of recent research developments in the important and vibrant area of sustainability in energy and buildings.

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As energy innovation becomes imperative for the environment and energy security, the law must be fleet-footed to evolve in an unwieldy area of policy. This much-needed text assembles experts to analyse the most recent developments, and to postulate how human rights, sustainable development, and the eradication of energy poverty could be achieved.

End of Energy Poverty and achieving Sustainable Energy for all by 2030 is a universal challenge. 1.3 billion people without energy access and 2.8 billion people using unsustainable solid fuel for cooking and heating are global challenges for human and societal sustainable development. Nearly \$1 trillion of investment is expected in the Sustainable Energy for All (SE4ALL) scenario to achieve universal energy access in 2030. Around 60% of investments will be in isolated off-grid and mini-grid systems with the relevant goal of duplicating the renewable energy sources in the energy mix. Access to innovation trends in renewable energy off-grid would benefit future installations. This work brings to light the recent years research contributions in Hybrid Renewable Energy Systems (HRES) and related aspects that would benefit these required investments in isolated off-grid and mini-grid systems. An overview on the thematic focus of research in Hybrid Renewable Energy Systems (HRES) in the last decade, period 2005 - 2015, is provided. This review covers multiple key aspects of HRES as the main focus of the research (technical, economical, environmental, financial, etc.); the design of the system (type of load, energy sources, storage, availability of meteorology data, etc.); different

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optimization criteria and objective function; software and modelling tools; and the type of application and country among others. A methodology for searching, identifying and categorizing the innovations related to HRES is proposed. Applying this methodology during this PhD work results in a primary database with a categorized bibliography including nearly 400 entries. Currently system design is mainly technical driven with economic feasibility analysis regarding the energy cost. As for environmental aspects, the beneficial impacts of renewable energy are hardly introduced as an economical value that is so far the most important decision-making criteria. Regarding decision-making tools, the most currently used optimization algorithms and software tools for the design of HRES is HOMER and a case study for understanding is proposed. Following the analysis of most popular and relevant criteria, an easy to use guideline is proposed encouraging decision-making for more sustainable energy access. There are untapped research opportunities for HRES in multi-disciplinary thematic areas. The analysis of innovations regarding the system design for Hybrid Renewable Energy Systems (HRES) have identified potential for research community aligned with the trends to integrate the value chain and foster innovative business models and sustainable energy markets. After the analysis of those different focus that goes from technical and economical, to environmental, regulatory or policy aspects, an integrated value chain for HRES systems is defined. Knowledge, methodologies & tools are provided in this PhD work for more stand-

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alone hybrid systems creating value for more of the stakeholders involved. After reviewing the latest innovations in HRES per thematic focus, an integrated value chain for those systems has been proposed and multidisciplinary research opportunities have been identified. Identifying the need to include the environmental aspects in early stages of the decision-making has lead to propose an easy to use guideline integrating most relevant criteria for the design of stand-alone renewable power systems. Finally, the research opportunities identified and the untapped potential of transferring latest innovations have result in the creation of the website ElectrifyMe (www.electrifyme.org) to enable valuable international networking contacts among researchers and encouraging multi-disciplinary research. "Knowledge, methodologies & tools" are powerful contributions by research community and innovators to foster more sustainable energy for all.

Despite decades of effort and billions of dollars spent, two thirds of people in sub-Saharan Africa still lack access to electricity, a vital pre-cursor to economic development and poverty reduction. Ambitious international policy commitments seek to address this, but scholarship has failed to keep pace with policy ambitions, lacking both the empirical basis and the theoretical perspective to inform such transformative policy aims. Sustainable Energy for All aims to fill this gap. Through detailed historical analysis of the Kenyan solar PV market the book demonstrates the value of a new theoretical perspective based on Socio-Technical Innovation System Building. Importantly, the book goes

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beyond a purely academic critique to detail exactly how a Socio-Technical Innovation System Building approach might be operationalized in practice, facilitating both a detailed plan for future comparative research as well as a clear agenda for policy and practice. Chapter 1 of this book is freely available as a downloadable Open Access PDF under a Creative Commons Attribution-Non Commercial-No Derivatives 3.0 license. https://s3-us-west-2.amazonaws.com/tandfbis/rt-files/docs/Open+Access+Chapters/9781138656925_oachapter01.pdf Chapter 6 of this book is freely available as a downloadable Open Access PDF under a Creative Commons Attribution-Non Commercial-No Derivatives 3.0 license. https://s3-us-west-2.amazonaws.com/tandfbis/rt-files/docs/Open+Access+Chapters/9781138656925_oachapter06.pdf

Modern societies face several structural problems such as transport congestion and greenhouse gas emissions due to the widespread use of fossil fuels. To address these important societal problems and achieve sustainability in the broad sense, major transformations are required, but this poses an enormous challenge given the complexity of the processes involved. Such transformations are called 'transitions' or 'system innovations' and involve changes in a variety of elements, including technology, regulation, user practices and markets, cultural meaning and infrastructure. This book considers two main questions: how do system innovations or transitions come about and how can they be influenced by different actors, in particular by governments. The authors identify the theories which can be used to conceptualise the

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dynamics of system innovations and discuss the weaknesses in these theories. They also look at the lessons which can be learned from historical examples of transitions, and highlight the instruments and policy tools which can be used to stimulate future system innovations towards sustainability. The expert contributors address these questions using insights from a variety of different disciplines including innovation studies, evolutionary economics, the sociology of technology, environmental analysis and governance studies. The book concludes with an extensive summary of the results and practical suggestions for future research. This important new volume offers an interdisciplinary assessment of how and why system innovations occur. It will engage and inform academics and researchers interested in transitions towards sustainability, and will also be highly relevant for policymakers concerned with environmental issues, structural change and radical innovation.

This series of books are the output of the research project called "Sustainable Development in Asia (SDA)", which was initiated by the Association of Academies of Sciences in Asia (AASA). They are comprised of one synthesis report, which entitled "Towards a Sustainable Asia: Green Transition and Innovation", and four thematic reports on natural resources, energy, the environment and climate change, and culture from particular perspectives of agriculture. They aim to: 1) investigate common sustainability issues faced by all Asian countries, including population increase, poverty alleviation, pollution control, ecological restoration, as well as regional problems, such as water shortage in

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West and Central Asia, energy security in Northeast Asia, development model & transformation in East Asia; 2) analyze and summarize of best practices towards sustainable development in Asia; 3) bring forward suggestions and policy options for promoting green transition, system innovation and sustainable development of Asia. With best practice guidelines for a sustainable Asia, this series of reports, for the first time systematically address the common challenges and regional problems in regard to Asia's natural resources use, pollution reduction and climate protection, sustainable energy development, and innovations for environment-friendly and culture-compatible agriculture. They will provide handy and useful information to researchers, government policy makers and the general public who have concerns about Asia's sustainable development. AASA is a scientific and technological organization in Asia, established in 2000, comprising of 26 member academies all over Asia. Its vision is to provide a forum for the discussion of all issues relevant to science and technology development and its application on national level within Asia.

"Unique in linking sustainable energy technologies with innovation and product design, this book offers clear explanation of both and case studies enabling readers to understand and design energy-efficient products in several different markets. The book integrates the subject areas that are necessary for the design of sustainable and energy-efficient products based on sustainable energy technologies. The theory provided is illustrated by cases of design projects and concepts in practice. With

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the book's methodological approach, the reader is able to apply the information and examples in their research projects or product design processes. This book fills a void in existing literature at the intersection of innovation processes, sustainable energy technologies, energy demand reduction, product development, and user behaviour, which requires an integrated view on the development of sustainable energy solutions. As such, the editors offer a unique publication in "product innovation in sustainable energy technologies and energy-efficiency" that corresponds to the growing interest in the field"--

This open access book examines the role of citizens in sustainable energy transitions across Europe. It explores energy problem framing, policy approaches and practical responses to the challenge of securing clean, affordable and sustainable energy for all citizens, focusing on households as the main unit of analysis. The book revolves around ten contributions that each summarise national trends, socio-material characteristics, and policy responses to contemporary energy issues affecting householders in different countries, and provides good practice examples for designing and implementing sustainable energy initiatives. Prominent concerns include reducing carbon emissions, energy poverty, sustainable consumption, governance, practices, innovations and sustainable lifestyles. The opening and closing contributions consider European level energy policy, dominant and alternative problem framings and similarities and differences between European countries in relation to reducing household energy use. Overall,

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the book is a valuable resource for researchers, policy-makers, practitioners and others interested in sustainable energy perspectives

ICT Innovations for Sustainability is an investigation of how information and communication technology can contribute to sustainable development. It presents clear definitions of sustainability, suggesting conceptual frameworks for the positive and negative effects of ICT on sustainable development. It reviews methods of assessing the direct and indirect impact of ICT systems on energy and materials demand, and examines the results of such assessments. In addition, it investigates ICT-based approaches to supporting sustainable patterns of production and consumption, analyzing them at various levels of abstraction – from end-user devices, Internet infrastructure, user behavior, and social practices to macro-economic indicators. Combining approaches from Computer Science, Information Systems, Human-Computer Interaction, Economics, and Environmental Sciences, the book presents a new, holistic perspective on ICT for Sustainability (ICT4S). It is an indispensable resource for anyone working in the area of ICT for Energy Efficiency, Life Cycle Assessment of ICT, Green IT, Green Information Systems, Environmental Informatics, Energy Informatics, Sustainable HCI, or Computational Sustainability.

A Chatham House and Earthscan publication We are making a mess of energy. What we're doing with it is leaving people in the dark and endangering the planet. But we could do much better. Keeping the Lights On shows how. In immediate, accessible,

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everyday language it describes a different way to think about energy, what we want from it and how we get it. Drawn from over 35 years of work from one of the leading voices in the field, the book describes how we have persisted in getting energy and electricity wrong. It suggests how we could go about getting them right, improving energy security and services while reducing costs and vulnerability, globally and rapidly. It offers a concise, focused and coherent presentation of an important central thesis: that electricity is an infrastructure issue, so we have to stop treating it as a commodity issue. The book discusses the timely and heated debates surrounding energy in an accessible and entertaining tone. It also includes a guide to terminology and a list of key organizations and contacts in the field. It gives a comprehensive introduction to the most important issues, providing the reader with innovative and expert ideas and solutions. Keeping the Lights On challenges sterile and damaging misconceptions, with an exhilarating vision of a brighter future. We can make energy use more reliable, more equitable, and more sustainable, for ourselves and our children, starting with electricity, starting now. Combining extraordinary historical insight with the sharpest analysis of where we are now, Walt Patterson carves out the most applied and practical of 'road maps' as to where we need to go if we are to deliver a genuinely sustainable electricity

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system for the future.--Jonathon Porritt CBE, chair, UK Sustainable Development Commission Clearly thought out, simply written, and straight to the heart of the major issues in energy today.--Ronan Palmer, chief economist, UK Environment Agency

In this important new primer, Dustin Mulvaney makes a passionate case for the significance of solar power energy and offers a vision for a more sustainable and just solar industry for the future. The solar energy industry has grown immensely over the past several years and now provides up to a fifth of California's power. But despite its deservedly green reputation, solar development and deployment have potential social and environmental consequences, from poor factory labor standards to landscape impacts on wildlife. Using a wide variety of case studies and examples to trace the life cycle of photovoltaics, Mulvaney expertly outlines the state of the solar industry, exploring the ongoing conflicts between ecological concerns and climate mitigation strategies, as well as current trade disputes and the fate of toxins in solar waste products. This exceptional overview will outline the industry's current challenges and possible future for students in environmental studies, energy policy, environmental sociology, and other aligned fields.

"The EU-funded project "Sustainable Consumption Research Exchanges" (SCORE!) consists of around 200 experts in the field of sustainable innovation and

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sustainable consumption. The SCORE! philosophy is that innovation in SCP policy can be achieved only if experts that understand business development, (sustainable) solution design, consumer behaviour and system innovation policy work together in shaping it. Sustainable technology design can be effective only if business can profitably make the products and consumers are attracted to them. To understand how this might effectively happen, the expertise of systems thinkers must be added to the mix. The publication in 2008 of System Innovation for Sustainability 1 was the first result of a unique positive confrontation between experts from all four communities. It examined what SCP is and what it could be, provided a state-of-the-art review on the governance of change in SCP policy and looked at the strengths and weaknesses of current approaches. System Innovation for Sustainability 4 is the third of three books of case studies covering respectively the three key consumption areas of mobility, food and agriculture, and energy use and the built environment - responsible for 70% of the life-cycle environmental impacts of Western societies - with the aim of stimulating, fostering or forcing change to SCP theory in practice. Energy consumption is obviously a key issue for sustainability, primarily because it depletes non-renewable fossil fuels, produces CO₂ and other pollution. As climate change is becoming a key

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political issue, and as oil prices rise, society has become acutely aware of this issue. Energy is a special case because it is a key input to almost all other consumption and production processes. Housing is, with transport and food, a major consumer of energy, accounting for about one quarter of the environmental impact from the general consumption of products in the European Union, on a par with food and transport. Energy use in houses and buildings is also set to rise as populations - and the buildings they need - continue to increase. In France, for example, energy consumption in houses and offices accounts for 43% of the total national energy consumption, and one-quarter of national greenhouse gas emissions. The UK's 21 million homes consume around 50 million tonnes of oil equivalent (responsible for 27% of UK CO₂ emissions); this energy use has increased steadily by about 1.3% per year since 1990. Germany's buildings contribute one-fifth of the country's CO₂ emissions. Beyond this, buildings are the environment where we spend most of our lives; they deeply influence many other consumption patterns, and are an important factor for life and comfort. The societal function and nature of buildings as they are currently constructed presents some key difficulties in moving towards sustainable consumption and production. Buildings have a long lifetime; and therefore they are a major target for any structural

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changes in consumption patterns. Conversely, long lifetimes come with associated strong inertia; therefore the stock of existing buildings is often an obstacle to policies aimed at behavioural change. This book examines, through a case study approach, opportunities to influence energy consumption in housing and buildings and thereby provide options for implementation at a macro, meso and micro level. A growing body of evidence shows that cases demonstrating action towards SCP in energy use in housing can inspire innovation through a range of actors. The cases include examples of steps towards the sustainable use of energy in houses and buildings, from "local experiments", to "innovative communities", to wider regime or non-local scale change in Europe and North America. The System Innovation for Sustainability series is the fruit of the first major international research network on SCP and will set the standard in this field for some years to come. It will be required reading for all involved in the policy debate on sustainable production and consumption from government, business, academia and NGOs for designers, scientists, businesses and system innovators."--Provided by publisher.

Electricity transmission and distribution (T&D) networks carry electricity from generation sites to demand sites. With the increasing penetration of decentralised and renewable energy systems, in particular variable power sources such as wind

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turbines, and the rise in demand-side technologies, the importance of innovative products has never been greater. Eco-design approaches and standards in this field are aimed at improving the performance as well as the overall sustainability of T&D network equipment. This multidisciplinary reference provides coverage of developments and lessons-learned in the fields of eco-design of innovation from product-specific issues to system approaches, including case studies featuring problem-solving methodologies applicable to electricity transmission and distribution networks. Discusses key environmental issues and methodologies for eco-design, and applies this to development of equipment for electricity transmission and distribution. Provides analysis of using and assessing advanced equipment for wind energy systems. Includes reviews of the energy infrastructure for demand-side management in the US and Scandinavia.

In this book Gregor Weber deals with enterprises and the pool of challenges including energy efficiency and sustainability they are confronted with. His research results in a two level model supporting enterprises on innovative and responsible business practices. It was awarded with the “Project Sustainability 2017” by the Council of Sustainable Development of the German government as well as with the “German Industry Award 2017”. ?

New innovations are needed for the invention of

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more efficient, affordable, sustainable and renewable energy systems, as well as for the mitigation of climate change and global environmental issues. In response to a fast-growing interest in the realm of renewable energy, *Renewable Energy Systems: Efficiency, Innovation and Sustainability* identifies a need to synthesize relevant and up-to-date information in a single volume. This book describes a systems approach to renewable energy, including technological, political, economic, social and environmental viewpoints, as well as policies and benefits. This unique and concise text, encompassing all aspects of the field in a single source, focuses on truly promising innovative and affordable renewable energy systems. Key Features:

- Focuses on innovations in renewable energy systems that are affordable and sustainable
- Collates the most relevant and up-to-date information on renewable energy systems, in a single and unique volume
- Discusses lifecycle assessment, cost and availability of systems
- Emphasizes bio-related topics
- Provides a systems approach to the renewable energy technologies and discusses technological, political, economic, social, and environmental viewpoints as well as policies

Ô. . . was impressed by the scope of the contributions and their clarity. All appear to have been written specifically for this ÔHandbookÓ and all are readily comprehensible without a large amount

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of assumed previous knowledge. . . a very useful source document and many of the chapters represent a good starting point for student research projects. Ò Ð Tony Owen, Economics of Energy and Environmental Policy ÔIn todayÕs modern world where energy resources are increasingly scarce, climate change is a hot-button issue, and population growth continues to push the need to promote sustainable living, Handbook of Sustainable Energy is highly recommended as an absolutely invaluable contribution to graduate school libraries and the pool of literature available to professionals in the field. Ò Ð The Midwest Book Review Major contemporary issues and debates relating to the sustainable use of energy are addressed in this far-reaching Handbook. The contributing authors discuss the ongoing debates about sustainability and energy use, energy economics, renewable energy, efficiency and climate policy. New and original chapters from leading academics cover the full spectrum of relevant research including: definitions of sustainability in energy use; consumer behaviour and energy markets; the impacts of innovation and new technologies; energy economics and climate modelling; low carbon economies and renewable energies. The authors critically engage with perspectives from developed and developing countries from both global and regional standpoints. This Handbook will make a timely and important

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contribution to the study of energy, climate change and climate economics, and will prove essential reading for international researchers in the fields of natural resources, climate change and energy.

Students in environmental science faculties, economics departments, business schools and engineering schools will also find this important and enriching compendium insightful. Similarly, policy-makers in energy and environment ministries and international organizations will find much topical debate to engage them.

Electricity production and consumption are at the heart of modern life and are therefore of great interest to public policy. Threats such as security of supply concerns, the volatility of fuel and electricity prices, and especially environmental concerns like climate change, are putting increasing pressure on current electricity systems. One key response by governments has been support for innovation. It is widely acknowledged that electricity systems will have to change fundamentally in order to deliver on political goals. This will require deep cuts in greenhouse gas emissions. Incremental change along established technological trajectories is unlikely to be sufficient. Instead 'system innovations' have been suggested as a solution by scholars and policy makers. What are the politics of such an endeavour? To answer this question this thesis looks at two distinct policy initiatives to promote more

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sustainable electricity systems: the 'Energy Transition' project in the Netherlands and the 'Carbon Trust' in the UK. While the aim of the two policy initiatives is similar, they try to tackle the challenge in very different ways. The analysis is based on semi-structured interviews as well as a review of documents and secondary literature and follows a process tracing method, combining within-case and cross-case analysis. By utilising a framework based on 'discursive institutionalism' (as per Hajer and Schmidt) the study aims to shed light on the importance of both discourses and institutional contexts in shaping policy initiatives to promote 'system innovations'. It demonstrates the mechanisms by which particular framings of the problem, expressed through new storylines, come to legitimate particular government policies. It emerges that existing institutions not only shape which storylines are politically acceptable but also constitute tangible features of the organisational and technical environment which those initiatives must change. In conclusion, the thesis argues that the politics of governing 'system innovations' can usefully be conceptualised and explained by struggles about meaning. These are shaped in turn through discursive interactions between actors as well as existing institutions. By highlighting the interplay between discourses, interests and institutions, the results provide an input to scholarly

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debate and policy making alike, in ways that offer to help inform the rethinking of strategies for fostering socio-technical 'system innovations'.

This book highlights progress towards the capture, storage, and utilization of energy through the development of advanced materials and systems based on abundant elements, materials, and commodities. Energy is critical to human sustainability and a global-scale deployment of renewable energy systems will be required. Hence, the chapters integrate the fundamental aspects that enable the technical advancements in detail, along with an emphasis on the need for highly sustainable materials to enable real impact for humankind: To determine innovation of energy capture and storage through characterizations of materials in areas of electrical generation and electrical storage systems; To demonstrate better performance, economic and environmental advantages than the current state of the art; To define new chemistries and materials for innovations in energy density design through lower operational temperatures, improve safety, expanding operational voltage, battery durability lifetimes, and reduce system costs.

Advances critical technical and commercial objectives for novel high energy density materials; Evaluates operational material models for optimizing energy capture that are integrated by configurations as a system; Illustrates utilization of material life cycle assessment for high energy outputs generators for sustainable materials.

In the recent past, environmental innovations have led to a considerable reduction of many pollutants; however, further innovation is required to tackle remaining pollution sources. This work analyses the significance and the effects of framework conditions on innovation activities that contribute to the realisation of a sustainable development. The book

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links the experiences of different research projects with the aim to develop a system of indicators to evaluate sustainable effects of (environmental) innovations. A comprehensive framework for an indicator system is established that allows to include different environmental innovation fields such as process innovations in the steel production, substitution of dangerous chemicals, organisational innovations in the field of waste disposal or sustainable water management.

This volume features research and case studies across a variety of industries to showcase technological innovations and policy initiatives designed to promote renewable energy and sustainable economic development. The first section focuses on policies for the adoption of renewable energy technologies, the second section covers the evaluation of energy efficiency programs and the final section provides evaluations of energy technology innovations. Environmental concerns, energy availability and political pressure have prompted governments to look for alternative energy resources that can minimize the undesirable effects for current energy systems. For example, shifting away from the conventional fuel resources and increasing the percentage of electricity generated from renewable resources, such as solar and wind power, is an opportunity to guarantee lower CO₂ emissions and to create better economic opportunities for citizens in the long run. Including discussions of such of timely topics and issues as global warming, bio-fuels and nuclear energy, the editors and contributors to this book provide a wealth of insights and recommendations for sustainable energy innovations.

Explores how these conflicting scenarios could be reconciled; how can we shape a more sustainable energy system from the existing one; and possible technological progress and innovations to enable a brighter future. Addresses the reality that there exists no consensus on the extent to which

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innovations can really contribute to reconciling ever-growing energy consumption, availability of resources and the environment, and the structural demands on any energy system. Offers and explains a four-point strategy: Energy should according to its importance regain a top priority in the political arena; highly targeted subsidies should be given for a limited amount of time to speed up the market introduction of energy-efficient and regenerative techniques in analogy to the 'Dutch model'; Negotiated agreements and unilateral self-commitments can subsequently ensure further market diffusion of sustainable energy innovations.; the basic research in energy should not be diminished but intensified instead

"This book presents an empirical study of the potential emergence of alternative, yet renewable, energy options as part of the energy system of the Kingdom of Saudi Arabia. The analysis is cast in the context of innovation system studies in order to look into the prospects for such sustainable innovation endeavours in this rapidly developing and major oil-producing GCC nation, whose economy is still heavily reliant on the unsustainable practice of oil sales. Given that no explicit innovation policy as such exists in Saudi Arabia, this book also provides inputs for the future development of a sustainable innovation policy for Saudi Arabia. It should be recognised, however, that the arguments made in this book are not conclusive only with regard to the context of Saudi Arabia. They may also be relevant to other oil producing countries (especially those in the GCC region) which seek a competitive position in the renewables arena. The book aims to investigate the prospects for sustainable innovation that would lead to the development of a sizeable renewable energy industry in the Kingdom of Saudi Arabia. More specifically, the book will examine the potential policy-orientated inducements (i.e. drivers) and

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blocks (i.e. barriers) that could either enable or inhibit the transition towards such sustainable energy systems."--Provided by publisher.

Innovation, Markets and Sustainable Energy is the first attempt to explore fuel cells and hydrogen technologies by embracing a solid theoretical perspective in the field of innovation and management. Adopting a cross-sectional and international perspective, the book analyzes the implications of introducing fuel cells into the industrial system and explores the complexity of market development for new technological solutions. This book presents an in-depth study of the hydrogen and fuel cell industry and markets, concentrating on the disruptive nature of these technologies. It examines the value chain structure and the strategies of relevant industry players, the alliances and inter-organizational learning processes, the development of new markets, and venture capital dynamics. It also provides an overview of the policies that support hydrogen and fuel cell technologies in major countries around the world. Academics focussing on innovation management, strategy, sustainability, and energy and environmental management will warmly welcome this timely book. It will also be of great interest for the fuel cell and hydrogen practitioner community at large and in particular policymakers.

This open access book addresses the issue of diffusing sustainable energy access in low- and middle-income contexts. Access to energy is one of the greatest challenges for many people living in low- income and developing contexts, as around 1.4 billion people lack access to electricity. Distributed Renewable Energy systems (DRE) are considered a promising approach to address this challenge and provide energy access to all. However, even if promising, the implementation of DRE systems is not always straightforward. The book analyses, discusses and classifies

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the promising Sustainable Product-Service System (S.PSS) business models to deliver Distributed Renewable Energy systems in an effective, efficient and sustainable way. Its message is supported with cases studies and examples, discussing the economic, environmental and socioethical benefits as well as its limitations and barriers to its implementation. An innovative design approach is proposed and a set of design tools are supplied, enabling readers to create and develop Sustainable Product-Service System (S.PSS) solutions to deliver Distributed Renewable Energy systems. Practical applications of the book's design approach and tools by companies and practitioners are discussed and the book will be of interest to readers in design, industry, governmental institutions, NGOs as well as researchers.

This book covers the state-of-the-art advances in several areas of energy, combustion, power, propulsion, and environment, focusing on the use of conventional and alternative fuels. It presents novel developments in the areas of biofuels and value added products from various feedstock materials, along with thermal management, emission control and environmental issues from energy conversion. Written by internationally renowned experts, the chapters in this volume cover the latest fundamental and applied research innovations on cleaner energy utilization for a wide range of devices extending from micro scale energy conversion to hypersonic propulsion using hydrocarbon fuels. The book will be useful as a ready reference for managers and practicing and research engineers, as well as graduate students and research organizations and institutions.

Innovation is key to achieving a sustainable electricity system. New technologies and organizational changes can bring about more sustainable, climate-friendly

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electricity structures. Yet the dynamics of innovation are complex, and difficult to shape. This book, written by experts in the field, sets out to explore the dynamics, the drivers and the setting of innovation processes. Case studies on micro cogeneration, carbon capture and storage, consumer feedback, network regulation and emissions trading provide insights into innovation dynamics in the electricity system and are analyzed to derive strategic implications for innovation policies. A special focus is placed on drivers and barriers of change, and their consequences for shaping the innovation process. This book is an indispensable source of information for researchers and decision makers in energy and climate change as well as for lecturers and students interested in the principles and ramifications of electricity innovation dynamics.

Critical assessment of the complete range of sustainable energy technologies for policy-makers and advanced students.

. . . this book is a timely and significant read for anyone with an interest in the operation of the energy sector.

Karen Morrow, International Energy Law & Taxation

Review This is a timely and comparative assessment of initiatives to promote renewable electricity sources (RES-E) in eight European countries. Carried out by the ProSus research programme at the University of Oslo in cooperation with leading research institutions in each country, the book focuses on the promotional schemes used to foster RES-E in Austria, Denmark, Finland, Ireland, the Netherlands, Norway, Spain and Sweden. The book is unique in that it monitors progress on

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implementing the EU RES-E Directive in relation to the impact of the dominant energy systems in each country. Employing notions of path dependency/path creation , the analysis demonstrates that crucial lessons for promoting RES-E are to be found in the contextual conditions of national and regional settings; conditions that qualify the effects of more general, market-oriented schemes. The conclusions reached are of direct relevance for the ongoing debate as to the most effective policy instruments for achieving sustainable energy and climate policies in Europe. Promoting Sustainable Electricity in Europe will be of interest to academics and researchers involved in environmental management, energy studies, technology and sustainable development. Furthermore, it will be of interest to policymakers and bureaucrats both at the EU level and among EU/EEA member states concerned with climate change, renewable energy and sustainable development at large. The book should also be of relevance for business organizations and NGOs concerned with the promotion of sustainable electricity.

This dissertation presents a set of analytical tools developed to investigate the energy system transition using a systems approach. The cases explored range from Kosovo, a country on the verge of new electricity supply investments, and future energy pathways to an analytical investigation of innovation in battery storage systems that could unlock the environmental and health benefits of intermittent renewable energy sources such as solar and wind technologies. The analytical tools compare existing metrics such as levelized cost of

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electricity with new metrics such as a two-factor learning curve of deployment and innovation and trace metal content of coal per final kWh of electricity delivered and energy return on investment of distributed energy systems. Chapter 1 investigates the case of Kosovo and introduces an analytic framework to analyze electricity costs and environmental impacts of future electricity options. The scheduled decommissioning of the Kosovo A coal-fired power plant provides an opportunity to investigate the changing cost of alternative energy options available in Kosovo for new energy infrastructure. I find that a range of investment pathways from international financial institutions and donor groups could meet the same projected electricity demand at a lower cost than building a new 600 MW coal fired power plant. The options include energy efficiency measures, combinations of solar PV, wind, hydropower, biomass, and the introduction of natural gas. The results indicate that financing a new coal plant is the most expensive pathway to meet future electricity demand in Kosovo. Chapter 2 utilizes the analytic framework developed to estimate the cost of future electricity pathways and uses green chemistry and public health risk assessment to estimate trace metal content of coal and investigate the air-pollution-related-health risks of lignite coal in Kosovo. By utilizing ICP-MS, I sample lignite coal for trace metal content and develop a risk model to assess future health impacts of air pollution from the electricity options explored in Chapter 1. I find significant trace metal content normalized per kWh of final electricity delivered. I estimate that Kosovo could avoid 2300 premature deaths

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by 2030 when introducing energy efficiency and solar PV backed up by natural gas. The framework highlights that often multi-lateral development banks do not account for all health risks before guaranteeing loans on new electricity projects. The interest in finding sustainable options to balance the load of intermittent renewable energy options in Kosovo motivates further analysis to understand how battery storage technologies have developed over time in terms of performance and cost. Chapter 3 examines the dramatically falling cost of battery storage options. I develop a two-factor technological learning curve model that integrates the value of investment in materials innovation and technology deployment over time from an empirical dataset covering battery storage technology. I find and chart a viable path to dispatchable \$1/W solar with \$100/kWh battery storage that enables combinations of solar, wind, and storage to compete directly with fossil fuel-based electricity options. I highlight the co-evolutionary nature of the cost reductions of battery storage technologies and suggest the relative importance of sustained investment and integration of R&D and deployment to develop innovative low-carbon combined solar, storage, and wind systems. Chapter 4 highlights the changing energy return on investment of energy technologies by investigating a case in Thailand where distributed solar, mini-hydro, and battery storage mini-grids are becoming an attractive investment and serve as core options to meet growing demand for electricity. I compare the net energy return on investment (EROI) of mini-hydropower, solar PV, and battery

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storage. This study represents a direct application of the opportunities for battery storage technologies to enable cost-competitive mini-grids in Thailand and around the world. The dissertation highlights different plans, designs, and future management of cost-effective, sustainable, and healthy electricity systems for a clean energy transition worldwide. The analytical tools presented combine to integrate traditional economic, environmental, and health metrics into energy systems planning and innovation. By integrating these interconnected systems, it becomes possible to enable cleaner and more sustainable energy transitions. The EU-funded project "Sustainable Consumption Research Exchanges" (SCORE!) consists of around 200 experts in the field of sustainable innovation and sustainable consumption. The SCORE! philosophy is that innovation in SCP policy can be achieved only if experts that understand business development, (sustainable) solution design, consumer behaviour and system innovation policy work together in shaping it. Sustainable technology design can be effective only if business can profitably make the products and consumers are attracted to them. To understand how this might effectively happen, the expertise of systems thinkers must be added to the mix. The publication in 2008 of System Innovation for Sustainability 1 was the first result of a unique positive confrontation between experts from all four communities. It examined what SCP is and what it could be, provided a state-of-the-art review on the governance of change in SCP policy and looked at the strengths and weaknesses of current approaches.

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System Innovation for Sustainability 4 is the third of three books of case studies covering respectively the three key consumption areas of mobility, food and agriculture, and energy use and the built environment – responsible for 70% of the life-cycle environmental impacts of Western societies – with the aim of stimulating, fostering or forcing change to SCP theory in practice. Energy consumption is obviously a key issue for sustainability, primarily because it depletes non-renewable fossil fuels, produces CO₂ and other pollution. As climate change is becoming a key political issue, and as oil prices rise, society has become acutely aware of this issue. Energy is a special case because it is a key input to almost all other consumption and production processes. Housing is, with transport and food, a major consumer of energy, accounting for about one quarter of the environmental impact from the general consumption of products in the European Union, on a par with food and transport. Energy use in houses and buildings is also set to rise as populations – and the buildings they need – continue to increase. In France, for example, energy consumption in houses and offices accounts for 43% of the total national energy consumption, and one-quarter of national greenhouse gas emissions. The UK's 21 million homes consume around 50 million tonnes of oil equivalent (responsible for 27% of UK CO₂ emissions); this energy use has increased steadily by about 1.3% per year since 1990. Germany's buildings contribute one-fifth of the country's CO₂ emissions. Beyond this, buildings are the environment where we spend most of our lives; they deeply influence many other consumption patterns, and

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are an important factor for life and comfort. The societal function and nature of buildings as they are currently constructed presents some key difficulties in moving towards sustainable consumption and production. Buildings have a long lifetime; and therefore they are a major target for any structural changes in consumption patterns. Conversely, long lifetimes come with associated strong inertia; therefore the stock of existing buildings is often an obstacle to policies aimed at behavioural change. This book examines, through a case study approach, opportunities to influence energy consumption in housing and buildings and thereby provide options for implementation at a macro, meso and micro level. A growing body of evidence shows that cases demonstrating action towards SCP in energy use in housing can inspire innovation through a range of actors. The cases include examples of steps towards the sustainable use of energy in houses and buildings, from "local experiments", to "innovative communities", to wider regime or non-local scale change in Europe and North America. The System Innovation for Sustainability series is the fruit of the first major international research network on SCP and will set the standard in this field for some years to come. It will be required reading for all involved in the policy debate on sustainable production and consumption from government, business, academia and NGOs for designers, scientists, businesses and system innovators.

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