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Editors

Systems, Decision and Control in Energy VII

Volume II: Power Engineering and Environmental Safety

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Preface

The imperative to meet global energy needs sustainably is a challenge that requires cross-disciplinary collaboration, innovation, and forward-thinking approaches. The book, *Systems, Decision, and Control in Energy VII, Volume II: Power Engineering and Environmental Safety*, captures recent scientific advances across four essential domains: Electric Power Engineering, Heat Power Engineering, Renewable Power Engineering, and Environmental Safety. This volume reflects the concerted efforts of Ukrainian and international researchers in advancing technologies and methodologies that shape the future of energy systems and environmental protection.

The first part, *Electric Power Engineering*, explores critical innovations in the generation, transmission, and distribution of electric power. As global energy demands rise, the development of efficient and reliable electric power systems becomes essential. This part includes studies on optimizing grid performance, enhancing resilience, and integrating smart grid technologies. Advances in grid automation, energy storage, and demand response are examined, reflecting the shift toward adaptive, efficient, and secure power systems. Contributions from both Ukrainian and international scientists highlight the importance of these technologies in balancing the load, minimizing losses, and ensuring the stability of the electric power grid under varying conditions. As the electric power sector is foundational to all other energy systems, these advancements underscore the need for robust, scalable, and intelligent electric power infrastructures.

The second part, *Heat Power Engineering*, addresses innovations in the generation and distribution of thermal energy. Heat power plays a vital role in industrial processes, residential heating, and energy-intensive applications, particularly in regions with cold climates. Researchers in this part present work on the optimization of heat transfer systems, combined heat and power (CHP) technologies, and efficient thermal energy storage solutions. This part underscores how modern heat power systems are evolving to maximize fuel efficiency and reduce emissions, with an emphasis on systems that balance thermal and electrical energy outputs. The studies presented here reflect significant strides in energy efficiency, environmental stewardship, and the integration of heat power engineering with other energy sectors. These contributions are especially relevant for achieving efficient and cost-effective

energy solutions that can be tailored to the diverse heating and industrial needs of communities worldwide.

The third part, *Renewable Power Engineering*, focuses on the development and integration of sustainable energy sources. Renewable energy technologies, such as wind, solar, hydro, and biomass, have become critical in reducing carbon emissions and achieving energy independence. The contributions in this part highlight advances in renewable energy production, storage, and integration with existing power systems. Researchers delve into areas such as photovoltaic efficiency, wind turbine optimization, bioenergy solutions, and hybrid renewable systems, providing insights into both the technological and economic aspects of renewable energy adoption. Ukrainian and international experts alike contribute their perspectives, advancing the understanding of how renewables can be harnessed effectively within diverse energy landscapes. By addressing technical challenges, such as intermittency and scalability, this part provides a roadmap for enhancing the accessibility and reliability of renewable energy sources.

The final part, *Environmental Safety*, encompasses research on mitigating the environmental impact of energy production and consumption. With energy systems being one of the primary sources of emissions and pollution, environmental safety has become a central concern in energy research. This part presents studies on emission reduction technologies, pollution control strategies, and sustainable waste management practices within the energy sector. It includes research on air and water quality and sustainable resource utilization, highlighting how environmental safety measures can be incorporated into all stages of energy production and distribution. Contributions here demonstrate how Ukrainian and foreign scientists are working to minimize the environmental footprint of energy activities, addressing the crucial intersections between energy production, environmental health, and public policy. By implementing innovative practices and technologies that reduce pollutants and manage waste, this part reflects a commitment to balancing energy needs with ecological preservation.

This book is a testament to the powerful synergy between research and real-world applications, emphasizing the value of collaborative innovation in addressing today's complex energy challenges. The contributions of Ukrainian and international researchers enrich this collection, fostering an exchange of ideas and solutions that cross geographic and disciplinary boundaries. Their work not only advances scientific knowledge but also provides actionable insights for policymakers, engineers, and industry leaders who are tasked with steering energy systems toward sustainability and resilience.

In assembling these chapters, we celebrate the achievements of the contributors, whose research represents a shared commitment to a more sustainable, reliable, and safe energy future. The ongoing collaboration between Ukrainian and foreign scientists exemplifies the benefits of global partnerships, allowing us to learn from each other and build a cohesive response to the challenges facing the energy sector. As energy systems evolve to meet the needs of a rapidly changing world, this volume serves as both a record of progress and a guide for future innovation.

It is our hope that this collection will inspire further research and foster new collaborations among scientists, engineers, and decision-makers dedicated to building a sustainable energy landscape. We extend our deepest gratitude to the authors, reviewers, and all those who contributed to the successful realization of this volume. May it serve as a valuable resource and a catalyst for continued advancements in electric power, heat power, renewable energy, and environmental safety.

We would also like to express our gratitude and respect to these institutions whose employees participated in the preparation of this book: General Energy Institute of NAS of Ukraine, State Institution "Center for evaluation of activity of research institutions and scientific support of regional development of Ukraine of NAS of Ukraine", Center for Information-analytical and Technical Support of Nuclear Power Facilities Monitoring of the NAS of Ukraine, Institute of Electrodynamics of the NAS of Ukraine, Institute of Engineering Thermophysics of the NAS of Ukraine, Anatolii Pidhornyi Institute of Power Machines and Systems of the NAS of Ukraine, Institute of Nuclear Power Plant Safety Problems of the NAS of Ukraine, G. E. Pukhov Institute for Modelling in Energy Engineering of NAS of Ukraine, Thermal Energy Technology Institute of the NAS of Ukraine, Institute of Geological Sciences of the NAS of Ukraine, Scientific and Research Institute of Providing Legal Framework for the Innovative Development of National Academy of Legal Sciences of Ukraine, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", National Technical University "Kharkiv Polytechnic Institute", Sumy State University, National University of Civil Defence of Ukraine, United Center for Information Protection, Institute of Public Administration and Research in Civil Protection, National University of Life and Environmental Sciences of Ukraine, Ivano-Frankivsk National Technical University of Oil and Gas, Admiral Makarov National University of Shipbuilding, Odesa National Maritime University, National University "Odesa Maritime Academy", National University of Civil Protection of Ukraine, National University of Food Technologies, Simon Kuznets Kharkiv National University of Economics, Interregional Academy of Personnel Management, State Ecology Academy of Postgraduate Education and Management, Ternopil Ivan Puluj National Technical University, National University of Water and Environmental Engineering, Ivano-Frankivsk National Medical University, Ministry of Defence of Ukraine, Progresstech Ukraine LLC, Research Laboratory and Experimental Center "BRAND TRADE" (all—Ukraine), Yuan Ze University (Taiwan), Systems Research Institute of the Polish Academy of Sciences (Poland), Warsaw University of Life Sciences (Poland), Universidad Autónoma del Estado de México (Mexico), DAGAS LLC (Poland).

This book is for scientists, researchers, engineers, as well as lecturers and postgraduates of higher education institutions dealing with energy sector, power engineering, environmental safety, etc.

Kyiv, Ukraine
November 2024

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Vitalii Babak

Contents

Renewable Power Engineering

Environmental Safety