

# SUSTAINABLE FUTURE

EXPLORING RENEWABLE ENERGY SOLUTIONS



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Peeyush Kr. Kamlesh



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## **EXPLORING RENEWABLE ENERGY SOLUTIONS**

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## Foreword



It is with great pleasure and pride that I extend my warmest greetings to all the readers of this seminal work, "Sustainable Future: Exploring Renewable Energy Solutions". As Chairperson of Nirwan University Jaipur, I am deeply honored to offer my thoughts on this remarkable compilation of scholarly work.

In an era where the world is confronted with the pressing challenges of climate change, environmental degradation, and diminishing fossil fuel reserves, the pursuit of sustainable energy solutions has emerged as an imperative for our collective future. This edited volume exemplifies scholars, researchers, and academicians' unwavering dedication to addressing these essential concerns and paving the way for a more sustainable tomorrow.

The journey towards sustainability demands collaboration, innovation, and a steadfast dedication to advancing knowledge and understanding. Through the collaborative efforts of esteemed contributors from diverse backgrounds and disciplines, this book presents a comprehensive exploration of renewable energy solutions, offering insights that are both enlightening and actionable.

From solar and thermoelectric power to hydrogen energy and photogalvanic cell, the chapters within this book delve into various facets of renewable energy, examining their potential, challenges, and implications for achieving a sustainable future. Each chapter demonstrates the profound impact that rigorous research and scholarly inquiry can have in shaping our understanding of complex issues.

As we navigate the transition towards a more sustainable energy landscape, it is imperative that we harness the power of knowledge, collaboration, and innovation to overcome the challenges that lie ahead. This book serves as a beacon of hope and inspiration, reminding us of our collective responsibility to protect our planet for future generations.

I would like to extend my heartfelt gratitude to Dr. Peeyush Kumar Kamlesh, for leading this ambitious endeavor. His vision and unwavering dedication have been instrumental in bringing this project to fruition.

I would also like to thank all the authors who have contributed their expertise, insights, and passion to this book. Your contributions have enriched the discourse on renewable energy and have the potential to drive meaningful change in the pursuit of a sustainable future.

I am confident that "Sustainable Future: Exploring Renewable Energy Solutions" will serve as a valuable resource for scholars, academicians, researchers, and all those committed to advancing the cause of sustainability. May this book inspire us to redouble our efforts in building a world where renewable energy powers the promise of a brighter tomorrow.

Warm Regards

**Dr. S. L. Sihag**  
*Chairperson*  
*Nirwan University Jaipur*

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## Acknowledgement

First and foremost, I express my deepest gratitude to the Almighty which has been my constant companion, illuminating my path and filling me with the resolve to pursue excellence.

I extend my heartfelt thanks to the Hon'ble Chairperson and Vice Chairperson of Nirwan University Jaipur (NUJ). Their invaluable guidance, unwavering encouragement, and visionary leadership have been pivotal in shaping the direction and fueling our aspirations towards greatness.

Words fall short in conveying my appreciation to the Hon'ble President of NUJ. Your profound wisdom, guidance, and unwavering support have been instrumental in shaping both my academic journey and the fruition of this work.

My sincere appreciation extends to all esteemed co-authors whose collaborative spirit, unwavering dedication, and profound expertise have enriched the pages of this book with invaluable knowledge and insights. Their relentless commitment to advancing research in the renewable energy sector has significantly contributed to the overall excellence of this literary endeavor. Your diverse perspectives, expertise, and collaborative spirit have made this book richer, motivating me to aim for excellence in my every endeavor.

I express profound gratitude to my colleagues for their support and encouragement in shaping this work. Their invaluable insights, constructive feedback, and unwavering belief in my capabilities have been a source of strength and motivation, driving me forward even in the face of challenges.



Special acknowledgment goes to Member Secretary, Publication, Nirwan University Jaipur, whose expertise and assistance have been indispensable in the publication process.

This book stands as a testament to the collective efforts and contributions of all those mentioned above. Your unwavering support and encouragement have been the cornerstone of this book, and I am profoundly grateful for the privilege of having journeyed alongside such exceptional individuals. Thank you for your invaluable contributions and unwavering support.

Sincerely,

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Scripta, delves into the structural and optical properties of hybrid perovskites. Dr. Choudhary actively presents her findings at national and international conferences, showcasing her expertise in sustainable development and materials for energy applications. Committed to academic growth, she participates in workshops on scientific computations and intellectual property rights.

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## Preface

In an era marked by growing environmental concerns and the urgent need for sustainable energy solutions, the quest for renewable energy sources has become crucial. This edited book represents a collaborative effort to illuminate the path towards a greener and more sustainable future. Each chapter within this volume exemplifies the brilliance and dedication of researchers who are committed to shaping a better world for future generations.

As the world is facing the consequences of climate change, the chapters within this volume unveil an array of renewable energy technologies, each possessing promise and innovation. From the inception of solar photovoltaic technology to the development of lead-free perovskite materials, from the brilliance of photogalvanic cells to the promise of ammonia as a clean fuel, this book traverses the cutting edge of renewable energy research.

I am privileged to have gathered a distinguished group of contributors, comprising esteemed scholars, researchers, world's top scientist and academicians. Their collective expertise and dedication have enriched the pages of this volume, providing valuable insights and perspectives on renewable energy technologies and their potential impact on global energy landscapes.

This book is intended for a wide audience, including research scholars, academicians, and scientists, who share a



common interest in advancing the discourse on renewable energy solutions. Whether you are a seasoned expert or a curious learner, we invite you to embark on a journey of exploration and discovery within this book.

As an editor, I extend my deepest gratitude to all the contributors whose expertise and dedication have enriched this volume. Their invaluable contributions have not only shaped this book but also contributed to the collective effort towards a more sustainable future.

I invite readers from all backgrounds to embark on a journey of exploration and discovery within this book. May the insights presented here stimulate meaningful conversation, innovative solutions, and useful steps toward achieving a sustainable future powered by renewable energy.

**Dr. Peeyush Kumar Kamlesh**

*Associate Professor & Associate Dean*

*School of Basic & Applied Sciences*

*Nirwan University Jaipur*

# Sustainable Future Exploring Renewable Energy Solutions



The book "Sustainable Future: Exploring Renewable Energy Solutions" offers a comprehensive exploration of alternative energy sources that have the potential to revolutionize our approach to power generation. This edited volume delves into a diverse array of renewable energy technologies, ranging from solar photovoltaics and thermoelectric materials to hydrogen energy and biofuels. Each chapter bears witness to the ingenuity and dedication of researchers worldwide who are committed to shaping a more sustainable future for generations to come.

The first chapter "Evolution of Solar Photovoltaic and Thermoelectric Technologies" describes the evolution of solar photovoltaic technology, tracing its journey from its inception to the cutting-edge third-generation solar cells, particularly perovskite and III-V semiconductor-based cells. Additionally, it sheds light on harnessing waste heat energy through thermoelectric solutions, emphasizing the pivotal role of sustainable energy in mitigating climate change.

The second chapter "Half-Heusler Thermoelectric Materials: Promises for Sustainability" explores the potential of half-Heusler thermoelectric materials in harnessing waste heat for energy generation. It highlights the unique properties of these compounds

and their applications in various technological domains, underlining their significance in the pursuit of sustainable energy solutions.

The third chapter “Silver Telluride Thin Films: Unveiling Renewable Energy Applications” unravels the remarkable properties and applications of silver telluride thin films in the realm of renewable energy. Through a meticulous examination of their synthesis, characterization, and potential for enhancing thermoelectric properties, it sheds light on their pivotal role in advancing renewable energy technologies.

Continuing the exploration of renewable energy sources, the fourth chapter “Halide Perovskites: Unlocking Optoelectronic Potential” delves into optoelectronic potential of perovskite materials, showcasing their versatility across various electronic devices. It delves into the unique properties of halide perovskites and their transformative impact on the electronics landscape, offering insights into their promising applications.

Investigating the structural, optical, and electrical properties of Ce-doped ZnO nanomaterials, the fifth chapter “Ce-Doped ZnO Nanomaterials: Harnessing Solar Energy” offers insights into their potential applications in solar energy conversion. It presents a detailed analysis of their synthesis, characterization, and suitability for energy conversion devices, highlighting their role in driving towards a sustainable energy future.

Addressing concerns over the toxicity of traditional perovskite materials, the sixth chapter “Lead-Free Perovskite Materials: Towards Sustainable Solar Cells” delves into the development of non-toxic and highly stable perovskite compounds for solar cell applications. It explores innovative approaches to overcome the challenges posed by lead toxicity, presenting a glimpse into the future of environmentally safe solar energy technologies.

The seventh chapter “Towards a Sustainable Hydrogen 2.0 Economy: Harnessing Ammonia for Renewable Energy” focuses on ammonia and its role in fostering a sustainable energy future. It examines efforts to produce ammonia from renewable sources like wind or solar power, emphasizing its potential as a clean and energy-dense fuel. While technical and economic hurdles persist, the chapter underscores ammonia's potential to contribute significantly to building a greener economy.

The eighth chapter “Powering Tomorrow: The Brilliance of Photogalvanic Cells” explores the brilliance of photogalvanic cells in directly converting light into electrical energy. Highlighting their significance in harnessing abundant solar energy without causing environmental harm, the chapter explores the workings of photogalvanic cells and their potential to revolutionize energy production. Despite existing challenges, such as improving efficiency, these cells offer considerable promise for clean and sustainable energy generation.

Lastly, the ninth chapter “Future Potential of Ethyl Alcohol as Renewable Motor Vehicle Fuel in India” explores the viability of ethanol, derived from sources like sugarcane, as a renewable fuel for vehicles in India. Against the backdrop of increasing concerns about pollution and climate change, the chapter evaluates ethanol's benefits and challenges as a cleaner alternative to conventional gasoline. It envisions how ethanol could help India reduce its reliance on fossil fuels while supporting its agricultural sector.

**Dr. Peeyush Kumar Kamlesh**  
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# ABOUT NIRWAN UNIVERSITY JAIPUR

Nirwan University, Jaipur was established by the Govt. of Rajasthan vide ACT No. 2 of 2017 and recognized U/s 2 (f) of UGC ACT 1956. The University has been empowered to award degrees under section 22 of UGC Act. NUJ has thirteen different faculties with seventeen schools. The University provides guidance and knowledge to the students in more than seventy programs ensuring high quality traditional and modern education. The University is situated in Jaipur, the capital of Rajasthan. NUJ is a successful venture of "NIRWAN CHARITABLE TRUST" and is one of the prominent choices for higher education among the students.

## ABOUT THE BOOK

"Sustainable Future: Exploring Renewable Energy Solutions" provides a comprehensive overview of diverse renewable energy technologies, from solar photovoltaics to biofuels. Each chapter highlights global researchers' commitment to sustainability, covering topics like solar technology evolution, half-Heusler materials, silver telluride films, and halide perovskites. The book also investigates Ce-doped ZnO nanomaterials and lead-free perovskites for solar energy applications. Additionally, it explores ammonia's role in sustainable energy, photogalvanic cells' potential in solar conversion, and ethanol as a vehicle fuel in India. This edited volume serves as a valuable resource for understanding and advancing renewable energy solutions.

## ABOUT THE EDITOR



**Peeyush Kumar Kamlesh**, currently serving as an Associate Professor and Associate Dean at Nirwan University Jaipur, is a distinguished scholar in the field of Physics with a focus on renewable energy solutions. Holding a Ph.D. in Physics from Banasthali Vidyapeeth, his research primarily revolves around half-Heusler and perovskite materials and their applications in renewable energy. With a robust research profile comprising numerous publications in SCI and SCOPUS-indexed journals, Dr. Kamlesh has contributed significantly to the scientific community. He possesses extensive experience in academia, having worked at various esteemed institutions. His expertise includes curriculum development and active learning methodologies. Dr. Kamlesh's dedication to his field is reflected in his involvement in numerous conferences, workshops, and seminars, where he has presented and convened on various topics related to sustainable energy technologies.



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