Green Technologies and Sustainable Development

Coherent Strategies for Developing Countries

Edited by

Léo-Paul Dana

Kirti Khanna

Green Technologies and Sustainable Development

This page intentionally left blank

Green Technologies and Sustainable Development

Coherent Strategies for Developing Countries

Edited by

Léo-Paul Dana
Dalhousie University, Canada

And

Kirti Khanna
Manav Rachna International Institute of Research and Studies, India

United Kingdom – North America – Japan
India – Malaysia – China

Emerald Publishing Limited
Emerald Publishing, Floor 5, Northspring, 21-23 Wellington Street, Leeds LS1 4DL

First edition 2026

Cover photo: Kanok Sulaiman, Hispanolistic, Ezequiel Becerra and Léo-Paul Dana

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-80592-187-5 (Print hardback)
ISBN: 978-1-80592-189-9 (Print paperback)
ISBN: 978-1-80592-186-8 (Ebooks)
ISBN: 978-1-80592-188-2 (Epub)

Typeset by TNQ Tech
Cover design by TNQ Tech

CONTENTS

ABOUT THE EDITORS

Prof Léo-Paul Dana is Professor at Dalhousie University and Visiting Professor at LUT School of Business and Management, Lappeenranta University of Technology. He is also associated with the Sorbonne Business School. A graduate of McGill University, he has served as Marie Curie Fellow at Princeton University and Visiting Professor at INSEAD and at Kingston University. He has published extensively in a variety of journals including: *Entrepreneurship: Theory & Practice*, *International Business Review*, *International Small Business Journal*, *Journal of Business Research*, *Journal of Small Business Management*, *Journal of World Business*, *Small Business Economics*, and *Technological Forecasting & Social Change*.

Dr Kirti Khanna is an Assistant Professor at the School of Leadership & Management, MRIIRS (India). She is Post Graduate in Commerce (International Business), and MPhil in Accountancy & Law (Commerce). She is awarded with the degree of Doctor of Philosophy (2014) in Accountancy & Law. Dr Khanna is an academician who has been engaged in research and teaching for the last 10 years. She had the honor of receiving the Best Paper Award at the International Conference Organized by the Research Development Association (RDA) & RDRF, Jaipur in collaboration with the Rajasthan Chamber of Commerce and Industry, Jaipur. She has experience organizing conferences and FDPs/MDPs and has also taken sessions as a resource person in workshops. Her areas of research interest are macroeconomic variables, stock markets, and companies' reporting practices, using updated analytical software such as STATA, SPSS, and E-VIEWS.

This page intentionally left blank

ABOUT THE CONTRIBUTORS

Richa Arora is currently working as an Associate Professor at School of Business, Sushant University, Gurgaon, India. She has over 9 years of experience in teaching, Research and Professional guidance. She is also UGC Net qualified and has contributed a lot in various national and International Journals, workshops, seminars and conferences. She has published more than 20 papers in Scopus indexed, UGC Care listed, WOS & ABDC indexed Journal. She is an author of the book titled—*Research Methodology and HR Analytics* written for postgraduation courses. She has convened various International and National Conferences and FDPs on Research Methods and Qualitative Research Analysis etc. Her areas of interest are Management Information System, Human Resource Management, Information Technology, E-Commerce, and Organization Behaviour.

Suman Bhatia is working as a Professor in Department of Artificial Intelligence and Machine Learning at Dr Akhilesh Das Gupta Institute of Professional Studies. She has vast experience in academics. Currently she is working on implementation of machine learning models for various real time scenarios towards sustainable development.

Arnab Chakraborty has more than 17 years of corporate and academic experience. He is currently working as an Associate Professor in School of Leadership and Management, MRIIRS, Faridabad. He has also worked as a Program Manager in Amity University, Noida; and HOD, Department of Management, College of Applied Education and Health Sciences, Meerut. He has conducted several MDPs, FDPs and training programs. He has published many research papers in Scopus indexed, UGC Care list and peer reviewed National and International journals. He has also written two books and has one patent publication. His area of interest is Developmental Economics, Digital Marketing and Marketing Management. He is a PhD in Economics, UGC NET qualified, MBA, PGDBM, and MA (Economics).

Asha Chaudhary is an experienced academician, researcher, and supervisor with over 18 years of core teaching expertise. She has actively contributed as an eminent speaker in various programs, including those under the Ministry of MSME and the IIT Kanpur Outreach Center. As a reviewer for the *Journal of Management Research and Analysis*, she brings valuable insights to academia. She currently leads preplacement initiatives and supports alumni activities, aiming to inspire creativity, integrity, and a passion for learning in her students.

Deepali Mayur Gala, an accomplished academician, holds an MBA, MPhil., and PhD in Business Management and has over 15 years of teaching experience. Currently serving as an Assistant Professor at Bharati Vidyapeeth (Deemed to be University), Kolhapur, she has significantly contributed to academia through teaching, research, and curriculum development. She has authored 24 research papers, including 4 indexed in Scopus and 5 in UGC Care-listed journals, along with several published book chapters. She actively participates in faculty development programs and has served as a resource person for sessions on innovation and entrepreneurship.

Komal Goel is a passionate Artificial Intelligence and Machine Learning (AIML) engineering student. With a strong interest in cutting-edge AI technologies, she actively explores innovative applications of machine learning and also have a keen interest in web development. She is fueled by curiosity and the desire to contribute to impactful projects and aspires to contribute to transformative AI-driven solutions while continuously advancing her technical expertise.

Sneh Gupta is Research scholar under the discipline of Marketing Domain at Chandigarh University. Sneh is possessing BCom, MBA, and MCom from Kurukshetra University. Having a Marketing and consumer behaviour as the foundational background, Sneh's initial research and academic interests revolve around Cause-related marketing and Blockchain with the endearing objective of understanding Consumer Behaviour.

Arvinder Kaur is working as an Assistant Professor at the University School of Business Chandigarh University, in the field of Finance since 2016. She has done Masters in Finance and Control with distinction Masters and graduation in commerce. She is a qualified member of Institute of Company Secretaries of India. Also, have a license as a distributor of Mutual Funds under NISM. She is currently pursuing PhD from Punjabi University, Patiala.

Rajinder Kaur is an Assistant Professor at the University School of Business, Chandigarh University, Mohali, Punjab. She has done PhD in Finance from the Department of Commerce, Punjabi University, Patiala. She holds

an MCom and BCom degree. She is UGC NET-JRF qualified in the commerce field. Her industry and academic experience extends to 7 years. Her research interests include investment management, volatility in Financial Markets, Derivatives and Event Study. She is the author of numerous articles published in national and international journals.

Amit Kumar is an Assistant Professor in the Department of UG Management Studies at FMS, MRIIRS, and is currently pursuing a PhD in Finance. He brings 14+ years of experience in education and over 5 years in the corporate sector, specializing in Finance, Taxation, Operations, and Statistics.

Raushan Kumar, has Currently Working as an Assistant Professor in Amity University, Gurugram. He has done his PhD in finance from Mahatma Gandhi Central University, Bihar and completed his Graduation from Sri Aurobindo College, University of Delhi and Post-Graduation from National PG College, University of Lucknow. He has been associated with Various Organizations and Contributed as an Active Member in Youth for Seva, Ekal Foundation, and NSS Delhi. He has authored more than 12 Research Papers, Book Chapters and Research Articles in National and International Journal. He has authored one book on *Financial Literacy: A Way to Financial Well-Being*. He has also presented more than five Paper Presentation in National and International Conferences. His area of Interest is Finance and Financial Inclusion.

Richa Nangia is a distinguished academician, researcher, and author with over 15 years of teaching and research experience. An MBA gold medalist and PhD graduate from the University of Rajasthan, she is currently an Associate Professor at the School of Business, Sushant University, Gurugram. Dr Nangia has authored *Research Methodology and HR Analytics* and serves as a reviewer for McGraw Hill's publications. With more than 50 research papers in reputed journals and 12 successful PhD supervisions, she is actively engaged as a reviewer and editorial board member for various Scopus-indexed journals. Her research interests include Organizational Behaviour, Training & Development, and Values and Ethics.

Susmit Pathak is an engineering student from New Delhi, India, with a keen interest in AI-driven solutions and cloud-based systems. He is currently working on developing innovative financial technology tools that leverage deep learning models for real-time analysis and predictions of stocks.

Bhakti Pawar specializes in the Economics, Marketing & Ecotourism. She holds a "Leadership and Management in New-Age Business" certificate from The Wharton School. She actively contributed to skill development in the National University Students Skill Development (NUSSD) project and received an RBI scholarship for her Project on Fintech. A prolific researcher,

she has presented papers globally, authored a book on Economic Analysis for Business Decision, and is a Life Member ofIndian Society for Ecological Economics (INSEE), New Delhi. She is a sought-after guest speaker at events organized by FIDD-RBI, K L University, and Bharati Vidya Bhavan.

Amita Rani is a highly accomplished professional with a PhD, MCom, MBA, and MPhil, bringing over 17 years of diverse experience in both academic and nonacademic roles within the statistical domain. With a strong research background, she has contributed extensively to the field through numerous publications in reputed journals. Skilled in statistical analysis and research methodologies, she excels in integrating theoretical knowledge with practical applications. Her expertise spans curriculum development, interdisciplinary research, and the advancement of statistical practices, making her a valuable contributor to the academic and professional community.

Savita is holding postgraduation to her credit namely; MBA. She has PhD in Finance from IKG-Punjab Technical University, Jalandhar. She has qualified UGC NET (2011, 2012). She has experience of more than 14 years in academics. She has presented papers in various National and International conferences. Dr Savita is a keen researcher, she has authored and co-authored more than 10 research papers published in Scopus, WOS, and UGC care listed journals. She is an author of various books i.e. *Navigating Financial Markets: A Theoretical Approach.* She has attended and conducted various seminars, workshops and Development Programmes in her field.

Renuka Sharma, Assistant Professor, Amity University, Haryana is a faculty of Finance and Accounting. Dr Sharma holds more than 12 years of experience in teaching and research. She holds a doctorate in Management. She holds a Master's degree in Business Administration and in Commerce and has cleared UGC-NET. Dr Sharma is an ardent researcher, she has authored and co-authored more than 15 research papers published in ABDC, Scopus, UGC care listed journals. She has presented various research papers in National and International conferences and has received Best Research paper award. She has published case studies in Case Centre, UK. She has attended and conducted various seminars, workshops and development programs in her field.

Vikas Sharma is an associate professor at the University School of Business at Chandigarh University. His academic journey includes a specialized MBA focusing on Finance, followed by a PhD in Management concentrated on Finance and Accounting.

Urvashi Sharma, Associate Professor, School of Leadership and Management has about 15 years of experience in Industry and Teaching. She did her PhD from Maharishi University Rohatk in 2018 after clearing UGC-NET Exam.

She has published several research papers in many refereed National and International Journals. She has also attended various National & International conferences/seminars, and presented research papers. She has authored/edited two chapters of books on Management with reputed publishers. She has organized a Faculty Development Program on Effective Teaching and Learning using social media.

Vinit Sikka serves as an Associate Professor with a PhD in Commerce and a professional qualification as a Company Secretary. With over 19 years of experience, his expertise spans Research, Teaching, Training, and Consulting in Economics, Finance, and Corporate Management. He has authored three international research papers and holds three patents. Dr Sikka is known for his strong communication and analytical skills, particularly in multicultural and multidisciplinary environments.

Rashmi Singel, an Associate Professor at the School of Leadership and Management, Manav Rachna International Institute of Research and Studies, has been a dedicated educator since 2004. She has taught undergraduate and postgraduate courses while actively serving on governance committees like the Board of Studies and Academic Council. Her research, published in ABDC, Scopus, and SSCI-WoS journals, focuses on rural entrepreneurship, women empowerment, and personal finance. Dr Singel holds multiple patents and engages in industry collaborations, frequently chairing conferences and contributing as a reviewer and resource person for initiatives such as IIT Kanpur's SIIC programs in partnership with the Ministry of MSME.

Atharva Singh is a passionate engineering student with a keen interest in Artificial Intelligence and web development. He thrives on solving real-world problems using innovative technologies, blending creativity with logic. He enjoys building intuitive web applications and exploring the transformative potential of AI in modern-day solutions. With a strong foundation in programming, he is always eager to learn and experiment with new tools and frameworks.

Sandeep Singh is acting as an Assistant Professor at University School of Applied Management Punjabi University, Patiala, Punjab, India. He is qualified in diverse areas like LLB, MBA in HR and PhD in Management. He has more than 13 years of experience in teaching and research. He is a member of numbers of professional and academic bodies and also serving as a member of Indian Commerce Association. He has published, his research in ABDC, SCOPUS and UGC listed journals. His key areas of research are related to procrastination behaviour, basic marketing, entrepreneurship and psychological issues in different sectors. He has acted as a resource person in various national level workshops related to primary data analysis.

Sonika Singh is an Assistant Professor at the Chandigarh Business School of Administration in Chandigarh Group of Colleges Landran, Mohali (Punjab) India. She did his Post Graduation (MBA) in Human Resource Management from the Himachal Pradesh Technical University Hamirpur and obtained his PhD from NIT Hamirpur (H.P.). She has published and presented research papers in national and international Scopus indexed journals as well as in conferences.

Ashish K. Singhal is working with the Government of India. He has Post-graduation Degrees/PG Diploma in Chemistry, History, "Public Policy in Sustainable Development" and "Training & Development." He is a Law graduate, too, and is now a research scholar in Human Resource Management. He is a National Level Resource Person in "Mentoring Skills" and a trainer in "Life Skills," "Gender Sensitisation," "Creativity and Innovation," IPRs, Govt of India's Rules & Regulations etc. He is a poet and writer.

Nandini Srivastava is the Director and Professor for the Council for Doctoral Programs at Manav Rachna International Institute of Research and Studies, with over 25 years of experience, including 21 years in management education. Previously, she served as Program Director at New Delhi Institute of Management for 13 years. She has published over 30 research papers, developed 11 MOOCS modules for the Swayam portal, and is involved in organizing key conferences. An advisor to multiple government bodies, Dr Srivastava has successfully guided 11 PhD scholars, with seven more currently under her supervision.

Mani Tyagi is award winning educator from the ICMEI—8th Dr. Sarojini Naidu International Award for Working Women held at Marwah Studios. She has 10+ years of experience in Industry and Academics. She is proficient in Marketing, International Business, and Corporate Training. She is a White Belt Holder of Six Sigma and a certified Project Manager from MSI, USA.

Shenki Tyagi was bestowed with the Young Influential faculty of the Year award—IISA 2022, bestowed with 6th Dr. Sarojini Naidu—The Nightingale of India International Award for working women 2022 in the Category of Educationist. She is working as a faculty at KIET Ghaziabad in the domain of Marketing and IIM Certified Digital Marketer. She is a Creative Director at I Transform Magazine by III.

Ankit Verma is working as a Professor and Head of the Department of Artificial Intelligence and Machine Learning at Dr Akhilesh Das Gupta Institute of Professional Studies affiliated with Guru Gobind Singh Indraprastha University, Delhi. He has vast experience in the industry as well as academia.

Anjali Yadav, a Research scholar, Pursuing PhD from Manav Rachna International Institute of Research and Studies, Faridabad, Haryana, and UGC-NET cleared in 2018. She has published several research papers in many refereed National and International Journals. She has also presented research papers at various National & International conferences/seminars. She has authored/edited one chapter of books on Management with reputed publishers. Her research interest lies in Human Resource Management and general management.

Ankita Yadav is currently an Assistant Professor at Amity University. She completed Bachelor's in Commerce from Gargi College, Delhi University, and my Master's in Commerce from Amity University Haryana. She is NET qualified and currently pursuing my PhD in Marketing. Her teaching expertise includes subjects related to taxation, Marketing, HRM etc. she focus on integrating theoretical concepts with practical applications.

This page intentionally left blank

FOREWORD

The modern era stands at the precipice of unprecedented environmental and economic challenges. Climate change, resource scarcity, biodiversity loss, and social inequalities are no longer abstract threats but pressing realities that shape the lives of individuals and communities, particularly in developing nations. In this context, green technologies offer a beacon of hope. Through innovation, efficiency, and sustainable practices, these technologies are instrumental in achieving a balance between economic growth, social equity, and environmental preservation—a balance essential for sustainable development. This book, *Green Technologies and Sustainable Development: Coherent Strategies for Developing Countries*, serves as a comprehensive guide, offering critical insights and strategies to leverage green technologies in the pursuit of sustainability in regions most affected by these global issues.

Addressing the Context of Developing Nations

Developing nations face unique constraints and opportunities. Rapid industrialization and urbanization often come at the cost of ecological degradation, overburdening natural resources, and straining social systems. This book recognizes that while sustainable development is a global goal, achieving it requires solutions tailored to the realities of each region. Through a robust examination of the current status of green technology in sectors such as energy, transportation, waste management, agriculture, and more, this volume addresses the multifaceted nature of sustainable development challenges faced by developing nations and provides actionable frameworks to overcome them.

A Multifaceted Approach to Green Technology

This book presents green technology not as a singular solution but as a suite of approaches and tools that together enable progress across various sectors. Green technologies are explored in their broadest application—from renewable energy sources and sustainable agricultural practices to water purification and eco-friendly urban planning. Each chapter delves into specific applications, benefits, and obstacles within the context of developing countries, emphasizing the necessity of an integrated approach to sustainable growth. Importantly, the book encourages governments, private enterprises, and communities to adopt these technologies not only to address current issues but to preemptively mitigate future challenges.

Financial Mechanisms and Economic Implications

One of the standout features of this work is its detailed discussion on the economic underpinnings of green technology adoption. Achieving sustainability requires substantial investments, and this book addresses the critical role of green finance in mobilizing these resources. Various funding mechanisms, from public-private partnerships to innovative financial instruments, are discussed to illustrate pathways for overcoming financial barriers. This economic perspective is especially relevant for developing nations, where the cost of green technology adoption can be prohibitive. By highlighting accessible and sustainable financial strategies, the book provides a roadmap for developing nations to fund green initiatives without compromising their fiscal stability.

Collaborative Pathways for Sustainable Impact

Central to this book's is the idea that green technology adoption must be a collaborative endeavor. Effective sustainable development relies on cooperation among diverse stakeholders, including governments, NGOs, the private sector, and local communities. The book underscores the importance of partnership in the adoption and scaling of green technologies. Through case studies and real-world examples, readers are presented with models of successful collaboration that can be replicated and adapted to various contexts. This focus on collective action is vital for ensuring that sustainable development initiatives are impactful and far-reaching.

Preparing for Future Challenges and Opportunities

Green technology is an evolving field, and this book looks beyond present-day applications to explore emerging trends and anticipated advancements. Chapters dedicated to the future of green technology provide insights into the evolving landscape of sustainable development, with a particular focus on digital transformation, biotechnology, and the circular economy. By anticipating future trends, the book enables readers to remain forward-thinking in their approach to sustainable development, equipping them with the knowledge needed to stay ahead in a rapidly changing world.

A Call to Action

This book serves not only as a repository of knowledge but also as a call to action for policymakers, researchers, and practitioners alike. Developing nations are at a pivotal moment where the decisions made today will determine their environmental, social, and economic futures. The authors of this volume, each an expert in their respective field, bring a wealth of knowledge and experience to the subject. Their insights are intended to inspire immediate, coherent actions, emphasizing that the journey toward sustainability is as much about timing and intention as it is about resources and technology.

Conclusion

Green Technologies and Sustainable Development: Coherent Strategies for Developing Countries is a meticulously crafted work that offers a robust framework for understanding and implementing green technologies. It challenges conventional development models and proposes a forward-looking vision grounded in sustainability. This book is an essential guide for those committed to transforming challenges into opportunities and ensuring that development today does not compromise the needs of future generations. As readers engage with the thoughtful analysis and practical solutions offered within these pages, they are invited to join a global movement toward a sustainable, resilient, and equitable future.

Charbel Salloum
Professor of Finance
EM Normandie Business School

This page intentionally left blank

PREFACE

Green technology and sustainable development are essential pillars for addressing the pressing environmental challenges and fostering holistic progress in developing nations. In developing economies, sustainable development stands as an overarching goal, encompassing economic growth, social equity, and environmental conservation. Achieving this equilibrium requires rethinking traditional approaches and integrating green technology solutions that can mitigate the adverse environmental effects often associated with rapid development. Green technology, characterised by innovation and efficiency, encompasses a wide array of practices and technologies designed to reduce resource consumption, minimise pollution, and promote a harmonious coexistence with nature.

The book *Green Technologies & Sustainable Development: Coherent Actions for Developing Countries* is a meticulously curated edited volume that brings together the expertise and insights of multiple authors, each contributing a unique perspective on the pivotal role of green technologies in advancing sustainable development within the context of developing nations. This collaborative effort results in a comprehensive guide that addresses the multifaceted challenges faced by these countries and offers actionable solutions through green innovation.

This book

i. Inform and Educate: Provide readers with a comprehensive understanding of the critical role that green technologies play in promoting sustainable development within developing countries.
ii. Address Financial Aspects: Discuss the role of green finance in financing sustainable development projects, offering insights into funding mechanisms, public-private partnerships, and innovative financial instruments.
iii. Promote Collaboration: Advocate for collaboration among stakeholders, including governments, NGOs, businesses, and communities, emphasizing the need for coherent and collective actions to drive sustainable development.

iv. Anticipate Future Trends: Discuss emerging trends, challenges, and opportunities in the field of green technologies and sustainable development, preparing readers for the evolving landscape.

Prof Léo Paul Dana
Dalhousie University, Canada

Dr Kirti Khanna
Manav Rachna International Institute of Research & Studies, India

CHAPTER 1

GREEN TECHNOLOGIES: KINGPIN FOR SUSTAINABLE DEVELOPMENT

Renuka Sharma
Amity University, India

Savita
Amity University, India

ABSTRACT

Purpose: The purpose of this study is to examine the significance of green technologies in addressing pressing environmental challenges such as climate change, biodiversity loss, pollution, and resource depletion. As societies recognize the urgency of sustainable development, the need for innovative technologies that reduce environmental impact while ensuring economic growth has become paramount.

Research Methodology: This study employs a systematic literature review to analyze various green technology (GT) innovations, including environmental biotechnology, green chemical engineering, bio-based materials, and sustainable energy solutions. It explores the effectiveness of these technologies in achieving sustainable development goals and enhancing resource efficiency.

Findings: Findings reveal that green innovations contribute significantly to reducing emissions, improving waste management, and fostering eco-friendly industrial processes. However, challenges such as high implementation costs, regulatory constraints, and limited awareness hinder their large-scale adoption.

Green Technologies and Sustainable Development, pages 1–16

doi:10.1108/978-1-80592-186-820251001

Implications: The implications of this study emphasize the necessity of collaboration between industries and governments to implement policies supporting GT adoption. Increased investment, policy reforms, and public-private partnerships can accelerate the transition to a sustainable future. By integrating green innovations, economies can achieve long-term resilience and environmental preservation.

Keywords: Green technology; emerging technologies; sustainable development; green economy; sustainability

Introduction

One of the most serious issues confronting businesses and society in the 21st century is climate change. Two of the top five most serious dangers confronting the world in the upcoming 10 years, according to the World Economic Forum's Global Dangers Report 2023, are "failure to mitigate climate change" and "failure of climate-change adaptation." The effects of the climate crisis can be severe and widespread if they are not addressed. The World Bank and the World Health Organization have estimated that by 2030, climate change will force over 120 million people into poverty and result in an additional 250,000 deaths per year from illnesses, heat stress, and starvation. If climate change is not addressed, the world economy is predicted to decline by 18% (compared to a world without global warming), according to a report by the Swiss Re Institute. Countries must use technology and methods for economic activity that are less detrimental to the environment and conserve resources given the developing global concerns.

To address global issues including climate change, population expansion, pollution, and resource depletion, countries must adopt environmentally conscious technologies and practices that conserves resources. Green technologies (GTs) have emerged as a silver lining in the cloud for issues at the global level and other environmental-related concerns. Researchers believe that the boost in the level of sustainable development will be a suitable reason for the growing number of sustainable economies and societies. Modern society is marked by technological breakthroughs that demonstrate human creativity and invention. On the other hand, those technologies have caused a localized worldwide disturbance of the biosphere. When it comes to fulfilling the requirements of economic sustainability, GTs have a bright future.

GTs are eco-friendly technologies which aim at economic and social sustainability (Davison, 2001). The term "green technologies" may sound fancy, but it simply refers to clean technology. GTs were formerly referred to as environmental technology (Huesemann & Huesemann, 2011). If one looks at GTs through the lens of Information System perspectives, these can be viewed as environmentally friendly products that decrease the production

of greenhouse gases (GHGs). They were once thought of as an expensive replacement for the ubiquitous, less expensive, non-sustainable technology. As a result, the three components of sustainable development—social, economic, and environmental—must be addressed (Ahmed et al., 2016; Manzoor & Ramay, 2013).

GTs promote sustainability by meeting human needs while reducing waste output and supporting life in the present and future (Wheeler & Bijur, 2000; Williams & Helm, 2011) Sustainable development must address all three dimensions: social, economic, and environmental (Ahmed et al., 2016; Biac, 2010). In a nutshell, it is green technology (GT) that stimulates sustainable development, which means identifying environmentally friendly sources of growth, developing new environmentally friendly industries, and creating jobs and technologies. Sustainable development is associated with less environmental damage and is driven by comprehensive and all-encompassing policies, both international and single countries, that consider the needs of future generations. Countries across the globe have begun the process of aligning economic growth with sustainable development goals (SDGs) targets. Among these policies, several suggest employing green technologies.

The development and adoption of GTs are crucial for achieving SDGs, as they can help reduce the environmental impact of economic activities while also promoting economic growth and job creation (Preston, 2018). Examples of GTs include renewable energy systems, sustainable agriculture practices, and eco-friendly building materials (Geng et al., 2019). These technologies can help to reduce greenhouse gas emissions, conserve natural resources, and improve the resilience of communities and ecosystems. By encouraging resource efficiency, lowering waste and pollution, and boosting the resilience of ecosystems and communities, GT and innovation are crucial for attaining sustainable development. This covers innovations in energy-efficient technology, sustainable agriculture, green infrastructure, and renewable energy. Promoting sustainable consumption and production patterns that give the utilization of renewable and sustainable resources priority is just as vital as creating and implementing green technologies.

What Is Green Technology

GT refers to goods, equipment, and systems that preserve natural resources and lessen the negative effect of human activity. It includes items, equipment, or systems that meet the following criteria:

- It minimizes environmental deterioration.
- It emits zero or low GHGs, is safe to use, and promotes a healthier environment for all living things.

- It reduces the consumption of energy and natural resources.
- It encourages the use of renewable resources.

Literature Review

Fu et al. (2021) stated that scientists have been working nonstop to come up with ways to preserve and protect the environment and build a sustainable future for the coming generations. The most recent advancements in GT are being developed, which can assist businesses in finding sustainable and alternative methods of getting rid of waste and in using more modern materials derived from biomass for low-cost, secure, and environmentally friendly products. GT is an umbrella term for the application of science and technology to reduce environmental consequences of human activity. It covers the scientific fields of energy, atmospheric science, agriculture, material science, and hydrology.

In many countries right now, installing it is less expensive than burning fossil fuels. It can be supported by purchasing stocks, bonds, and mutual funds that support eco-friendly technology. To lessen the negative influence on the environment and produce eco-friendly goods, companies should embrace cleaner manufacturing practices with the support of sustainable development processes and activities (Ikram et al., 2020).

Hoareau et al. (2021), and Awomeso et al. (2010) highlighted the relevance of sustainable practices that encourage pollution reduction, environmental impacts throughout the life cycle, opening new markets, and the development of new goods, services, or procedures are examples of how GT manifests itself in this context. Due to their critical role in attaining sustainable development, GT adoption and sustainable waste management have attracted the attention of a lot of researchers. Growing numbers of people on the planet and rising living standards have contributed to the creation of a huge amount of garbage, which has raised worries about pollution, health effects, and environmental damage. Several GTs try to lessen climate change by cutting emissions of GHGs including CO2 and others. The finest GT is solar power. In many countries right now, installing it is less expensive than burning fossil fuels. GT can be supported by purchasing stocks, bonds, and mutual funds that support eco-friendly technology (Hou et al., 2023).

Malka et al. (2023), Zhao et al. (2022), and Sun et al. (2019) stated that Green technological innovation (GTI) can play a vital role in uplifting EE and contracting the carbon footprint of energy creation.

GTI is a technology that aims to reduce its impact on the environment and encourage sustainable growth. This technology can be found in many forms, such as clean production, energy-efficient, and renewable energy technologies. Sharif et al. (2020), Kocaarslan and Soytas (2019), Fujii and Managi (2019), and Hu et al. (2019) said the market's need for more environmentally friendly that and energy efficient goods and procedures, as well as technical advancements that have made it possible for new types of GTI, have also fueled the development of green technologies. The globe needs to make significant investments in GTs if it is to meet strict environmental quality regulations and experience robust economic growth. Depletion of natural resources is on the rise due to increasing population pressure and expanding industrial development and it's a matter of concern in terms of inequality in social, wealth, and environmental obligation. Businesses will have to think more about sustainable technologies in terms of their products and services so that the interest of future generations can be preserved through innovative and environmentally friendly practices. Corsi et al. (2019) achieved a harmonious development between the economy and the environment during the production process, green technological innovation aims to protect the environment. This is achieved through developing products and technologies that help save energy and raw materials, as well as through using energy efficiently. The behavior of indicators should be monitored and it should be seen how they vary in the case of fluctuations in development (Boichenko et al., 2019).

Abbas et al. (2019) and Fujii and Managi (2019) added that by fostering economic growth and environmental preservation, sustainable GTs greatly contribute to a sustainable society. Following that, particular focus should be placed on factors that influence the innovation of sustainable GTs as well as the distinctions in their respective development goals. It will also lessen the negative effects of their operations, businesses have an obligation to reduce waste, use energy and water more efficiently, recycle, monitor, repurpose byproducts, and preserve natural resources. These are just a few of the business processes and practices that make up a company's environmental responsibility.

Wang et al. (2015) explained GT initiatives aim to have an impact on several areas, most notably energy, health, and wealth, while also reducing the harm done to the environment (Zhu & Ye, 2018). In every area almost, the concept of sustainable development and the growing adoption of GTs have gained momentum. Dhillon and Kaur (2015) explained how green hospitals in the health sector contribute to climate change. The resources needed to deliver contemporary healthcare are quite restricted. Hospitals work 24 hours a day, 365 days a year, employing cutting-edge medical skills to perform complex medical treatments demand the use of proper lighting

and temperature. This cannot be done without extra power. Climate change is inescapable, but modern healthcare sometimes exaggerates its impact. Hospitals are resource-intensive, requiring significant amount of power, water, nourishment, and building materials for optimal upkeep. It was also observed that many healthcare institutions might considerably minimize their environmental footprint by implementing simple, inexpensive, and long-term actions.

Soni (2015) and Banerjee and Alkuli (2014) studied that implementing GT provides organizations with a competitive edge and helps them grab market share. Green innovation minimizes costs for input, energy, maintenance, and manufacturing processes. Furthermore, it helps to improve the goodwill of the company. Implementing GT presents obstacles due to its higher cost and environmental impact compared to traditional technologies. The benefits of this technology rely on aspects such as supporting infrastructure, technical readiness, human resources, competencies, and geography. Arundel and Kemp (2009) elucidated that GT is a significant new idea for businesses and nations that set policy. Comparing these technologies to pertinent alternatives, their impact on the environment is lower. Innovations might be non-technical (based on organizational, institutional, or commercial principles) or technological. Additionally, related practices may be driven by environmental or economic factors, such as the desire to limit pollution, save expenses associated with resources, manage waste, or sell eco-products on the global market. Qi et al. (2010), Bartlett and Trifilova (2010) and Rennings (2000) recognized GT as a creative tool for delivering environmentally friendly products, services and processes. It ensures high-quality products or services with less impact on the environment.

Sectors Using Green Technology

Energy Sector: The fact that burning fossil fuels produces the bulk of the energy used in the world today. In place of fossil fuels, GT may be employed to create more ecologically friendly, alternative fuel sources. Waste is often a byproduct of the manufacturing of fossil fuels. Since renewable energy sources don't affect the environment and don't generate any waste products, they may be utilized in place of fossil fuels, such as solar, wind, and hydroelectric dams.

Transportation Sector: Conventional fuel-powered automobiles are one of the main sources of greenhouse gas emissions worldwide. As a result, a lot of businesses are implementing GT into their vehicles and transportation infrastructure, such as electric cars and compressed natural gas buses.

Waste Management Sector: The waste management industry also uses GT for the recycling, storage, and transportation of trash.

Water Filtration: GT is being utilized extensively for water purification all around the world. In places where there is a shortage of water, GT may be utilized to remove salt from saltwater or clean up contaminated water to increase the availability of safe drinking water.

Air Purification: By reducing the emissions of gases and carbon from the industrial sectors, GT is also being utilized to clean the air that has been contaminated.

Green Technologies for Sustainable Development

Reducing the environmental effect of economic operations requires the use of GT, such as renewable energy systems, sustainable agricultural methods, and eco-friendly construction materials (Geng et al., 2019; Preston, 2018). Preston (2018) and Geng et al. (2019) stated that these technologies help lower greenhouse gas emissions, preserve natural resources, and increase community resilience. One of the main forces behind sustainable growth in industries like transportation, energy, and agriculture is the adoption of GT (Geng et al., 2019).

Applications of Green Technology

Sustainable Urban Planning and Design

By establishing livable communities that put environmental concerns first, sustainable urban planning and design support sustainable development (UN-Habitat, 2016). To promote sustainable urban environments, compact, mixed-use developments, green spaces, and sustainable building techniques are essential (UN-Habitat, 2016). These methods improve living standards, advance economic growth, and lessen their negative effects on the environment (UN-Habitat, 2016). Conventional buildings are the main source of GHGs. However the creation of green buildings has been the sector's main priority (Cassidy, 2003; Ghaffarian Hoseini et al., 2013). Following climatic shifts like global warming, Green Building Practices (GBPs) are becoming more and more popular worldwide (Aithal et al., 2016; Biac, 2010).

Healthcare and Medication

The application of nanotechnology to enhance the environmental sustainability of processes that result in adverse externalities is known as "green

nanotechnology." It entails using nano products to advance sustainability and processing green nano products. The application of nanomaterials for feasible fuel cells, more effective solar cells, and ecologically friendly batteries is currently being studied. The most sophisticated Energy-related nanotechnology activities include energy conservation, increasing use of renewable energy sources, storage, conversion, and improvements in manufacturing by reducing materials and process speeds. Since green nanotechnology has a special affinity for refractory impurities, it also has a lot of potential for treating water.

Sustainable Transportation

A transportation system that has a favorable environmental impact is considered sustainable. A sustainable environment will result from the production of green vehicles using existing GT, which will reduce greenhouse gas emissions as compared to ordinary automobiles (Biac, 2010; Jagarajan et al., 2017). Compared to conventional automobiles, electric vehicles are turning out to be a more practical choice. When it comes to air pollution and greenhouse gas emissions, electric cars and trucks are turning out to be even more environmentally friendly than the most efficient conventional automobiles.

Clean Industries

Industries that reduce environmental damage are referred to as clean industries. GTs are used by clean industries in both product manufacturing and long-term initiatives that lead to sustainability (Davison, 2001; Klimova et al., 2016). The terms "clean industry" and "green industry" can be used interchangeably to describe businesses that work to address environmental issues (Huesemann & Huesemann, 2011).

Agricultural Technology

GTs are being applied to increase agricultural planting and harvesting efficiency, reduce the need for chemical pest and weed control, and provide fertilizers that reduce soil erosion and water pollution (Jagarajan et al., 2017).