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Green Technologies and Their Contribution to a Sustainable Global Economy in 2020-2025: A Literature Review

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Abstract: Eco-efficiency and a sustainable economy are the new rhythms of the world's economic stride. Green technology is shaping the world, ensuring economic progress with environmental responsibility. In academics, green technology is taking center stage, with many countries having developed frameworks for the adoption and incorporation of green technology into mainstream economic activities. As a result, the objective of this study is to examine the effect of green technology on global economic sustainability. The study carried out a qualitative assessment of the effects of this carbon-efficient technology on global economic sustainability using content and thematic analysis in the literature found through comprehensive searches over multiple online platforms. The selection of these studies was informed by the year of publication (2020-2025), as well as peer-reviewed articles, journal articles, and conference papers. The study found that clean energy occupies the most researched area of clean technology, with over 35% of the research papers focusing on clean energy. This is followed by waste management, with 27% of the papers focusing on clean waste management and 20% of the papers focusing on clean water treatment technologies. Clean production accounted for 12%, and clean logistics accounted for 6% of the total research papers. The study also found that green technology is fundamental to ensuring a circular economy. It is therefore concluded that green technology enhances the sustainability of the global economy. This study recommends that policies encouraging investment in green technology, particularly in developing countries, support interdisciplinary research on incorporating green technology into mainstream economic activities and standardize regulations and compatible frameworks to facilitate technology integration across industries.

Keywords: carbon footprints, circular economy, eco-efficiency, environmental responsibility, clean technology, renewable energy.

Introduction

Recently, a key challenge confronting the world's economy is the threat of environmental hazards alongside climate change (Mantaeva et al., 2021; Wani et al., 2024). The primary objective of economic sustainability is to strike a balance between economic growth and development while promoting positive environmental change (Barros et al., 2021). This, therefore, presents a significant challenge because the processes of production and economic growth consume natural resources, leading to their depletion and adverse environmental impacts (Sharif et al. 2024; Raihan 2023).

The depletion of limited natural resources and climate change, driven by the rapid growth of the global population and the economies of newly industrialized countries, hurt the environment. This situation has led to a broad acknowledgment of the necessity for innovative approaches to economic growth and development. Such approaches should aim to minimize the strain on natural resources and improve environmental conditions for the population by utilizing alternative sources of growth (Nasedkina et al., 2021). In 2008, the World Bank initiated the "Strategic Framework for Development and Climate Change" to enhance and coordinate efforts from both the public and private sectors in addressing climate change. The World Bank Green Bonds exemplify the type of innovation the institution aims to promote within this framework.

Over time, a correlation has been observed between the environment and economic growth, which appears parasitic, as growth occurs only through the depletion of the environment. However, environmental degradation and depletion have significant costs to human lives; not only do they endanger people's health, but they also have a detrimental impact on their financial stability and overall productivity. Economic activity is directly proportional to increased energy consumption, resulting in a rise in greenhouse gas emissions that negatively impact the environment (Raihan, 2023). In recent decades, numerous studies have explored the key factors contributing to environmental degradation and their impacts on economic growth.

The analysis of Grossman and Krueger in 1991 initiated a discussion regarding the potential connection between environmental degradation and economic progress. Grossman and Krueger's research stimulated numerous scholarly contributions, which led to a flourishing of research on the environmental consequences of economic expansion (Khan et al. 2021a; Ge et al. 2025). Most of these studies found that growth is detrimental to environmental sustainability due to the effects of production and economic growth on carbon emissions and the depletion of the ozone layer. While stating the likely consequences of climate change, Khan et al. (2020) noted that climate change would cause a severe fall in the world economy, resulting in a loss of more than 18%. Therefore, this calls for a paradigm shift from the classical growth model, which focused on saving, investment and the rate of capital depreciation, to a more realistic model that supports sustainable growth. This model has come to be known as the model of "green economic growth". The United Nations stated in its 2015 Sustainable Development Agenda (SDAs) that establishing a more sustainable global economy will help lower greenhouse gas emissions that are responsible for climate change.

In the context of economic growth, sustainable development (Alao et al., 2022) is defined as development that meets the needs of the current generation while ensuring that future generations' ability to satisfy their own needs is guaranteed. The Paris Agreement has brought together several countries, committing them to reduce greenhouse gas emissions to tackle global climate change. To ensure the mission's success and the attainment of the Sustainable Development Goals (SDGs), Wani et al. (2024) noted that governments must demonstrate a steadfast commitment to the defined targets.

The ability of future generations to satisfy their own needs is guaranteed. Many countries have united under the Paris Agreement, pledging to reduce their greenhouse gas emissions to combat global climate change. To ensure the success of the mission and achieve the Sustainable Development Goals (Aravindaraj and Chinna, 2022), nations must demonstrate an unwavering commitment to the established targets (Wani et al., 2024). By incorporating environmental factors into economic planning, green economic growth aims to achieve sustainable development (Mensah, 2019) and ensure carbon-free, environmentally conscious, and socially equitable growth, thereby maximizing the benefits of natural resources, minimizing environmental harm, and promoting sustainable economic growth. According to Khan et al. (2020), green economic growth is an extension of the economic growth paradigm that prioritizes social sustainability and environmental preservation while simultaneously fostering economic advancement.

Climate change, resource depletion, and the adverse environmental impacts of production and consumption activities have continued to generate widespread concerns, underscoring the need for accelerated efforts toward environmental sustainability. Research has shown that green technologies, being eco-efficient, promote a circular economy. These aspects of green technologies include energy-efficient solutions, efficient waste product management, and effective logistics. However, the contribution of clean technologies to the circular economy is constrained by several elements that limit the realization of green technologies' potential to ensure economic sustainability (Fritz, 2022). Some of the factors often cited in the literature include huge initial capital requirements, inadequate research, and a lack of uniform environmental legislation, among others.

Research Problem

Early environmentalists have expressed concerns about the ecological impact of human activities on the sustainability of the environment (Khan et al., 2021b). The rapid industrialization and economic growth of the past centuries were accompanied by a significant carbon footprint and resource depletion, posing a great concern for the sustainability of the global economy. In response to these challenges, environmental scientists and technologists have developed green technologies and sustainable production systems, such as clean energy and water management technologies, to stimulate the sustainability of the world's ecosystem (Wani et al., 2024). Green energy, circular manufacturing, sustainable agriculture, and responsible supply chains are some of the clean technologies that have been

recognized as enhancing the environmental sustainability of the ecosystem (Zeng et al., 2024; World Economic Forum, 2023).

Technologies such as efficient production systems, energy systems, and environmental systems have been introduced to foster a circular economic system. Although green technologies are transforming the world's production and energy systems, their integration into the mainstream economic system remains a concern (Raihan et al., 2022). Furthermore, there is a need to identify the role of green solutions in the global economy, given the recent adoption and subsequent steps by countries in terms of environmental legislation (such as the Paris Agreement), the EU's targets for greenhouse gas emissions to be reduced by at least 55% by 2030, and national policies aiming for net-zero emissions, as well as the energy crises and severe economic changes of recent times. The broad adoption and integration of green technologies into mainstream economic systems, especially in technologically advanced nations such as the Netherlands, the United Kingdom, Finland and others, are testaments to the efficiency of these technologies in fostering a circular economy.

Green technologies lead to a clean and efficient energy system, a sustainable environmental system, efficient logistics, and improved water management, all of which enhance production and economic growth. However, despite the benefits of green technologies, concerns have been raised in some quarters regarding the affordability of these technologies and their potential to severely impact employment and job security, especially with their widespread adoption (Ogiemwonyi et al., 2023).

Empirical research on the functioning of green technologies in the global sustainable economy is advancing. While several studies (Mantaeva et al., 2021; Kumar and Shobana, 2024) confirm that green technologies are essential for global sustainability, other studies have raised concerns regarding the economic impact of green technologies, their scalability, and their integration.

The current study aims to demystify the role of green technology in the sustainable global economy. This study presents an assessment of the available literature on green technologies and economic sustainability, enabling readers to gain a general understanding of the impact of green technologies on promoting a sustainable global economy. It can also provide valuable insights into optimizing technological advancements for economic and ecological benefits, aiding future research in sustainable innovation and policy development.

While extensive research has been conducted on specific clean technologies, such as solar energy, wind power, and sustainable agriculture, their collective impact on the global economy remains underexplored. Available research often focuses on discrete elements rather than adopting a comprehensive approach that integrates economic frameworks with technological advancements.

This article aims to identify the key trends, obstacles, and opportunities for advancing "green" technology by analyzing the scientific research on its effects on a sustainable global economy.

Research Focus

This study examined the effect of green technology adoption on global economic sustainability. By utilizing a circular economic model of production and consumption, waste and pollution can be minimized through recycling, reusing, repairing, and refurbishing existing products and materials for as long as possible, thereby extending product lifespans and maximizing resource efficiency.

Research Aim and Research Questions

This article's objectives are to provide an overview of the role of green technologies as outlined in the literature, highlight the current trend in the shift to a green economy, and pinpoint how green technology enhances economic sustainability.

This article aims to analyze existing scientific research on the effects of clean technologies solutions on a sustainable global economy to identify the main trends, challenges, and prospects for their development.

As a result, the study considers the following specific objectives:

1. to identify the kind of clean technologies that are most prevalent in the world economy;
2. to examine the effect of "green" technologies on key macroeconomic indicators such as GDP growth, employment level, and innovative development;
3. to identify the challenges and limitations to the large-scale implementation of "green" technologies in different countries?

Literature Review

Sustainable economy

The concept of a sustainable economy is based on the idea that a country's prosperity is not the only factor determining its well-being; a healthy environment and habitat are also crucial. The notion of a sustainable economy has gained increasing recognition in the modern world, as it is prevalent in numerous works of literature on environmental and development issues. A vast literature has been devoted to the study of economic sustainability, of which the following are just a few examples: Mantaeva et al. (2021), Dragomir & Dumitru (2022), Singh et al. (2022), Ogiemwonyi et al. (2023), Sharif et al. (2024), and Ali et al. (2025).

According to Mantaeva et al. (2021), there are currently many definitions of a sustainable economy. They noted that most definitions emphasize that sustainability requires decisions that recognize the relationship between economic growth and its impacts on the environment, economy and society. A sustainable economy is a process that ensures a higher standard of living for everyone by striking a balance between social advancement, economic expansion, and environmental preservation, now and in the future (Vijaya et al., 2024).

To attain economic equilibrium and, thus, optimal resource allocation, the consumption and production structures in the agricultural economy must be compatible (Jiang et al., 2021). Underemployment, which is a feature of subsistence farms, is eradicated with the shift from subsistence to diversified farms. In essence, scientific advancements and innovations in agricultural production are what drive transition (Wang et al., 2025).

Green Economy

In 1989, the term "green economy" was first introduced in a study commissioned by the UK government for environmental economists as part of consultations on sustainable development and its measurement (Nasedkina et al., 2021). The Earth Summit in Rio de Janeiro in 1992 underscored the importance of developing the concept of a "green economy" to ensure the global economy's sustainability. According to the International Chamber of Commerce, the "green" economy consists of environmental responsibility and economic growth that work in tandem to promote social development (Nasedkina et al., 2021). The green economy paradigm fosters a healthy balance between societal and economic needs, as well as the need for long-term environmental restoration and preservation. Many governments of industrialized nations currently have distinct plans for green economic growth, which include primary aims, objectives, and specific targets for implementation. For instance, practically every EU nation has implemented new "green" policies in the areas of energy, infrastructure development, public transportation, and vehicle recycling systems (Dong et al., 2021).

The term "green economic growth" refers to economic growth that considers the responsible use of natural resources, reduces environmental pollution, and creates potential to improve social wellbeing by developing a carbon-neutral economy. It is closely related to the sustainable development paradigm (Barros et al., 2021). Kumar and Shobana (2024) define a green economy as one that enhances human well-being and social fairness while significantly reducing environmental risks and ecological scarcity. Environmental sustainability, resource efficiency, Social Equity, and a low-carbon economy are features of a green economy (Raihan et al., 2022).

Green Technology

The term "green technology" describes the creation and application of technologies that reduce the adverse effects of human activity on the environment and society (Kumar and Shobana, 2024). In this study, green technology refers to innovations that ensure the circular use of resources for sustained economic growth with minimal environmental impact. It encompasses a broad range of goods, services, and methods that promote a more sustainable future. The term "green tech," which is frequently used, is gaining popularity due to resource depletion, the environmental impact of production and industrialization, and the need to sustain the ecosystem. Green technology developers utilize scientific knowledge and creativity to promote the adoption of clean energy sources, reduce greenhouse gas emissions, and protect natural resources.

Geothermal energy, biomass, hydroelectric power, wind power, and solar energy are all efficient sources of energy. Green technology can contribute to the development of more sustainable products and more effective resource disposal. Advanced recycling facilities, which convert waste into valuable resources such as energy or raw materials for manufacturing, are examples of waste management technologies. These facilities also include waste-to-energy systems, which convert waste materials into electricity through controlled burning. Rechargeable battery-powered electric vehicles, including buses, trucks, and cars, contribute to a reduction in emissions from fossil fuels (Sebbani et al., 2025). Green tech also includes technologies that clean water for safe reuse. Green technology is equally effective in agriculture, reducing the environmental impact of food production while preserving food security through sustainable agriculture and smart farming (Archana et al., 2022).

Green technology aims to safeguard the environment, correct past environmental damage, and conserve the planet's natural resources. It entails the creation and implementation of products, services, and processes that use renewable resources, minimize emissions, and increase energy efficiency. The primary purpose is to address environmental concerns and support economic prosperity (Sharif et al., 2024). Sharif et al. examined technical innovation in developing industrial economies, proposing that technological advancements are crucial for easing ecological pressure amid rapid economic and industrial transformation. As a leader in the global economy, the World Bank created the "Green Bond," which collects funds from fixed-income investors to support World Bank loans for qualified projects that aim to mitigate climate change or assist impacted individuals in adapting to it. The product was created in collaboration with Skandinaviska Enskilda Banken (SEB) to meet investor demand for a triple-A-rated fixed income instrument that supports climate-related projects. This is to increase investment in green technologies and accelerate the transition to sustainability.

One of the areas where green technology has had a significant impact is in energy, transportation, waste management, and manufacturing (Vijaya et al., 2024). Solar energy, wind turbines, and hydrocarbon energies are becoming a reliable source of energy for households and businesses. Electric vehicles (EVs) and hydrogen fuel cells are becoming prominent in logistics infrastructure, while waste-to-energy initiatives are cleaner and safer environmental management solutions. Smart manufacturing, which reduces carbon emissions, is another example of how green technology is altering transportation, energy, environmental management, and industrial production processes. These developments are meant to lessen the carbon footprint that comes with transportation (Haldar and Sethi, 2022).

Preparedness for Green Technology Transition

In 2023, 166 nations were categorized by the United Nations Conference on Trade and Development (UNCTAD) based on their preparedness for implementing green technologies. Despite being the least equipped to employ cutting-edge technologies, developing nations have pointed out that several Asian economies have implemented significant policy reforms, enabling them to outperform their peers in terms of GDP per capita. With a ranking 67 spots higher than anticipated, India remains the biggest overperformer.

The Philippines and Vietnam come in second and third, respectively, with 54 and 44 spots higher. According to the score, nations in sub-Saharan Africa, the Caribbean, and Latin America are the least prepared to utilize cutting-edge technologies, risking a missed opportunity to capitalize on current technological advancements. A similar comparison rating of 76 countries and territories based on their capacity to create a low-carbon, sustainable future was indexed in the Green Future Index 2022.

It measures the extent to which economies are transitioning, through innovation, green legislation, and investments in renewable energy (Khare and Bhuiyan, 2022), toward a cleaner energy future encompassing industry, agriculture, and society. Concerning the aggregate scores produced across the following five pillars — carbon emissions, energy transition, green society, clean innovation, and climate policy — the rankings display the performance of the examined economies in comparison to one another (Table 1). This index measures a country's readiness to transition from carbon emissions to a clean or sustainable economy. Table 1 shows that Iceland leads the ranking of countries, while South Korea occupies the 10th position on the index.

Table 1

Circular Economic Transition Readiness

S/N	RANK	COUNTRY	SCORE
1	1st	Iceland	6.9
2	2nd	Denmark	6.6
3	3rd	Netherland	6.4
4	4th	United Kingdom	6.3
5	5th	Norway	6.2
6	6th	Finland	6.2
7	7th	France	6.1
8	8th	Germany	6.1
9	9th	Sweden	6.1
10	10th	South Korea	6.0

Note: Table 1 is an abridged version of the GFI (2022) that shows the top 10 ranking.

Source: Green Future Index (2022).

Theoretical approaches

Externalities and Pollution

Early economists believed that economic growth could coexist with environmental protection while stimulating innovation and profitability. In his 1920 essay "The Economics of Welfare," Arthur Pigou (2017) observed that the disparity between marginal private costs and benefits and marginal social costs and benefits produced what is now known as externalities. These externalities manifest as side effects of economic activity or as costs or benefits that are not reflected in the prices of goods and services. Pigou proposed imposing a tax on activities that generate negative externalities at a rate that balances private and social costs. This tax is known as the Pigou tax. The Pigouvian tax was introduced to guarantee that market prices more accurately represent the costs and benefits of economic activity. However, the practical application of the Pigou tax proved extremely challenging, resulting in regional and worldwide environmental difficulties (Radhakrishnan et al., 2025).

It was discovered that the market economy is unable to adequately distribute natural resources and provide an acceptable monetary value for their damaging use. Taking A. Pigou's arguments into account, later economists conceptually supported the notion that environmental pollution is an indication of wasteful resource utilization (Mantaeva et al., 2021). Based on this, it was stated that advances in industrial processes that reduce environmental pollution are the necessary conditions for achieving a balance between ecology and economy (Porter & Van Der Linde, 1995). Therefore, it means that environmental criteria can spur innovation and, consequently, enhance competitiveness and

profitability, as the authors' study shows that competitive advantages are directly related to the ability to innovate. Regarding the negative externalities associated with environmental reimbursement, they argue that the green productivity concept is based on the combination of two fundamental progressive methods: productivity augmentation and environmental precaution. While environmental stewardship lays the groundwork for long-term economic growth and sustainable development, productivity offers the framework for continuous improvement.

Theory of Sustainable Development

Economists have always overemphasized the market's ability to allocate resources effectively, presuming that the quantity of natural resources is limited. They expected that technological advancements would restore natural resources depleted during production, accompanying economic expansion. However, the expanding size of the economic system has overstretched the natural resource base, leading to a reexamination of the conventional economic postulations after it was discovered that natural resources are not limitless and that not all of them are renewable or replenishable.

The theory's origins can be traced back to the physiocrats, Malthus, and modern theorists such as Beck and Luhmann (Zakirov, 2022). Cultural theory offers insights for understanding and rethinking sustainable development. Many scholars have begun to doubt the viability of unchecked growth and consumption. Meadows' "Limits to Growth" and the Brundtland Commission's "Our Common Future" are essential sources of inspiration (Quental & Lourenço, 2012). Despite criticism, this concept is nonetheless crucial to human and planetary survival (Zahedi, 2019). Zahedi proposes an integrated strategy that incorporates political, economic, social, technological, and ecological issues on local to global scales while considering past, present, and future conditions.

In practice, sustainable development promotes circular economies, the use of renewable energy sources, sustainable agricultural practices, and ethical industrial operations. However, obstacles such as policy gaps, financial constraints, and resistance to change impede full implementation. Addressing these challenges will necessitate collaboration among governments, businesses, and communities to achieve a truly sustainable global economy.

Research gaps

Despite substantial studies on green technology and sustainable development, several gaps exist in the literature. These gaps highlight areas that require further investigation to understand the relationship between green technology and sustainability properly. Limited studies on the socioeconomic consequences of green technology. The majority of research focuses on environmental advantages, with little study of how green technology affects social fairness and wealth distribution. Inadequate research has been conducted on the impact of adopting green technology on employment displacement in traditional industries. The significance of green technology in poverty alleviation has received little attention, particularly in developing countries. Similarly, most research focuses on technology breakthroughs rather than overcoming financial, cultural, and institutional barriers to adoption. The lack of thorough studies on the impact of policy incentives and subsidies on promoting green technology is a significant gap in the literature. Moreover, the majority of the literature focuses on green technology in wealthy countries, with less attention paid to its impact in low-income countries, where unemployment, poverty, and subsistence living are prevalent. The lack of case studies examining how local inventions and indigenous knowledge contribute to sustainable development is particularly concerning.

Empirical Review

Mantaeva et al. (2021) noted that numerous theories of sustainable development have emerged, emphasizing environmental friendliness while sustaining long-term economic growth. These theories are referred to as the concept of sustainable development. In the same vein, the ecological component of sustainable development focuses on humanity's attitude toward the ecosystem, "green" technologies as the foundation for inventive growth, and the safeguarding of future generations' rights to

environmental quality. The study found that the majority of advanced countries are already concentrating on the advancement of "green" technologies, including geothermal energy, hydropower, wind, solar, and bioenergy. The creation of "green" energy has the potential to be a major driver of national economic growth without endangering the environment, given the rising demands of nations for energy resources. Nasedkina et al. (2021) analyzed the three components of the "green" economy – economic, social, and environmental – and provided evidence for the necessity of growth in the green economy in Russia. According to the study, the production of organic agricultural products, diversification of energy sources, rational use of natural resource potential, environmental protection, modernization of housing and public services, and the development of new ecological behaviors in the populace are the main areas of green technology investment in Russia. It also argued that the environmental component is a priority for sustainable development.

Haldar and Sethi (2022) employed the Environmental Kuznets Curve (EKC) hypothesis for the entire sample. They utilized Driscoll-Kraay Panel Corrected Estimators to examine the direct and indirect effects of Information and Communication Technology (ICT) on the environment through interactions with renewable energy, innovation, trade, and financial development for 16 emerging nations between 2000 and 2018. The study found that while an increase in non-renewable energy consumption significantly raises CO₂ emissions, a corresponding increase in internet use, trade, and renewable energy consumption substantially lowers emissions. Innovation and internet use work together to lower CO₂ emissions. Similarly, increased mobile use reduces CO₂ emissions through innovation, trade, financial development, and the adoption of renewable energy. It is found that the EKC hypothesis applies to both mobile and internet use.

Ahmed and Elfaki (2023) investigated the externalities transfer impacts of green technological advancements on the sustainable economic growth of fifteen economies in Latin America, Asia, and the Pacific. The study used energy consumption as a stand-in for unmeasured pollutant emissions and CO₂ emissions as an unintentional output or private unpriced input to quantify labor and capital contributions to green total factor productivity growth. The results verify that the growth rates of Total Factor Productivity (TFP), a measure of green technological advancement, were impacted by the high levels of air pollutant emissions produced by these nations' economic development.

Song et al. (2022) investigated the relationship between environmental laws, green technological advancements, and total factor productivity, utilizing data from Chinese A-share companies that relied on natural resources between 2004 and 2018. This study examined the importance of ecological, social, and technological factors in production improvement. One of the key elements of the Fourth Industrial Revolution, as identified in their research, was the development of green technologies.

Materials and Methods

This study employed a qualitative research method, utilizing a comprehensive evaluation of existing literature. Its goal is to use content analysis to reveal structural development and trends in green technology and the sustainable economy.

Sample and Participants

Peer-reviewed research published in the past six years (2020–2025) was thoroughly evaluated through extensive searches across multiple internet platforms.

Instruments and Procedures

Through the use of a string of keywords (such as "Green Technology," "Green Consumption," "Eco-efficiency," "Carbon Footprint," and "Sustainable Economy") developed based on brainstorming and prior reviews on green technology and sustainable economy by researchers, this study retrieves information and the full text of journal articles through Scopus and Web of Science (search mechanism and material acquisition). The study identified a total of 86 related publications, and after refinement,

fifty-three studies comprising forty-five journal articles, three conference papers, and five peer-reviewed articles were included.

Data Analysis

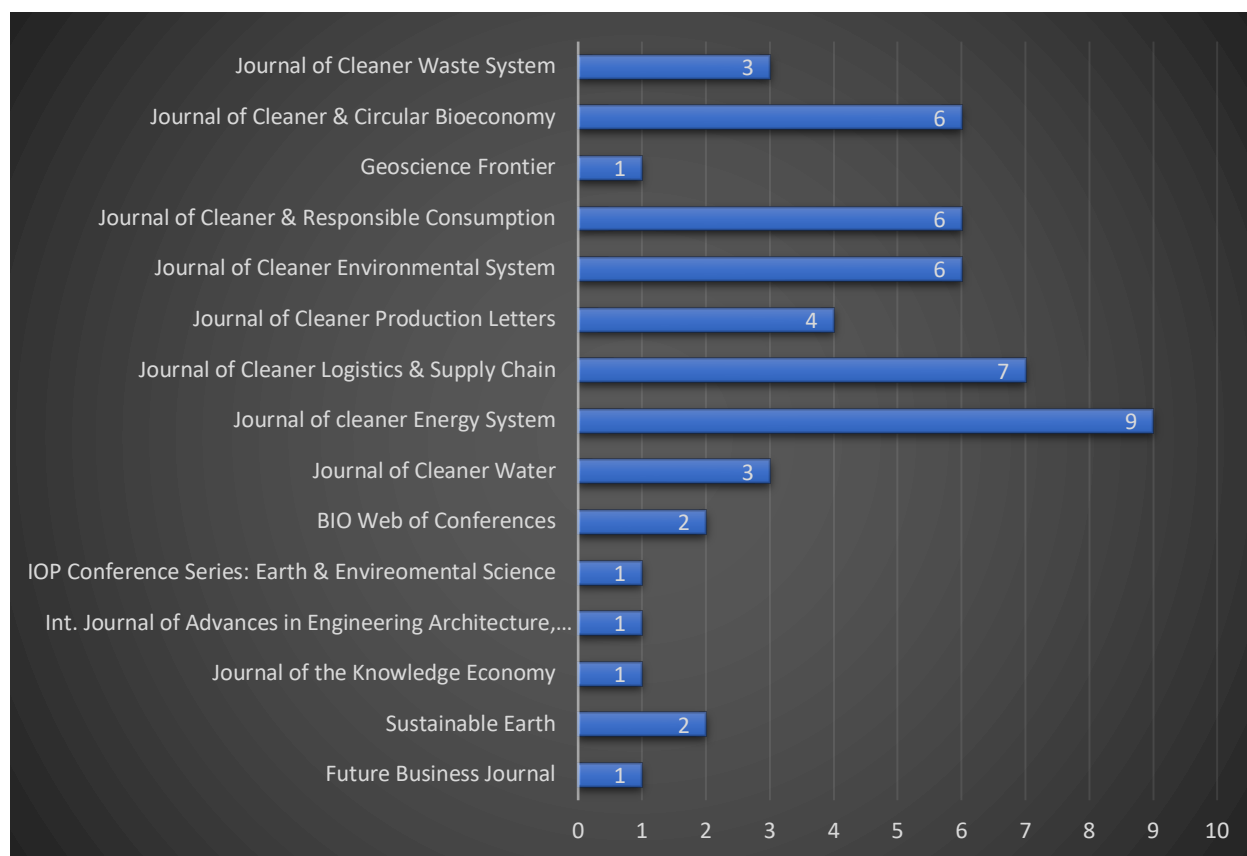
Information retrieved using the procedure above is analyzed through content analysis and thematic analysis, aided by graphs and charts.

Results

The publications included consist of research articles and review articles in English. The study rejected publications whose themes did not meet the study's requirements after thoroughly reviewing the titles and abstracts, ultimately selecting fifty-three articles from the literature. The classification of the sampled articles, based on the publication journals, is presented in Figure 1 below.

Figure 1

Journal Spread of the Included Articles



Source: Author's development.

The studies examined under each of the fifteen journals in Scopus, Web of Science, and other sources were selected based on availability, relevance, peer-reviewed articles, and year of publication. Regarding the year of publication, the distribution of the selected studies is presented in Figure 2 below.

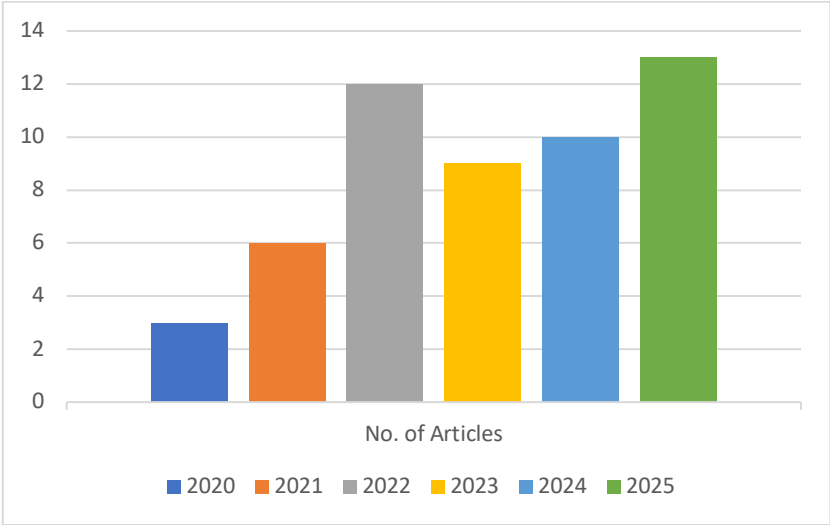
The included studies are analyzed using content analysis, and thematic analysis was used to extract information from these journals. The study only includes papers that meet the following requirements to prevent selection bias: (1) year of publication must be between 2020 and 2025; (2) sustainable economy must be the subject of the research (3) Studies must fundamentally be quantitative (4) study must address one of the research questions raised in this study.

This would not only ensure that current issues and trends in green technology and sustainable economy are presented, but it also allows for reasonable conclusions to be drawn regarding the research questions of the current study.

Figure 2 indicates that while publications about green technology and the sustainable economy have been rising steadily since 2020, the growth was more significant in 2022 and 2025.

Figure 2

Time Spread of the Included Articles



Source: Author’s development.

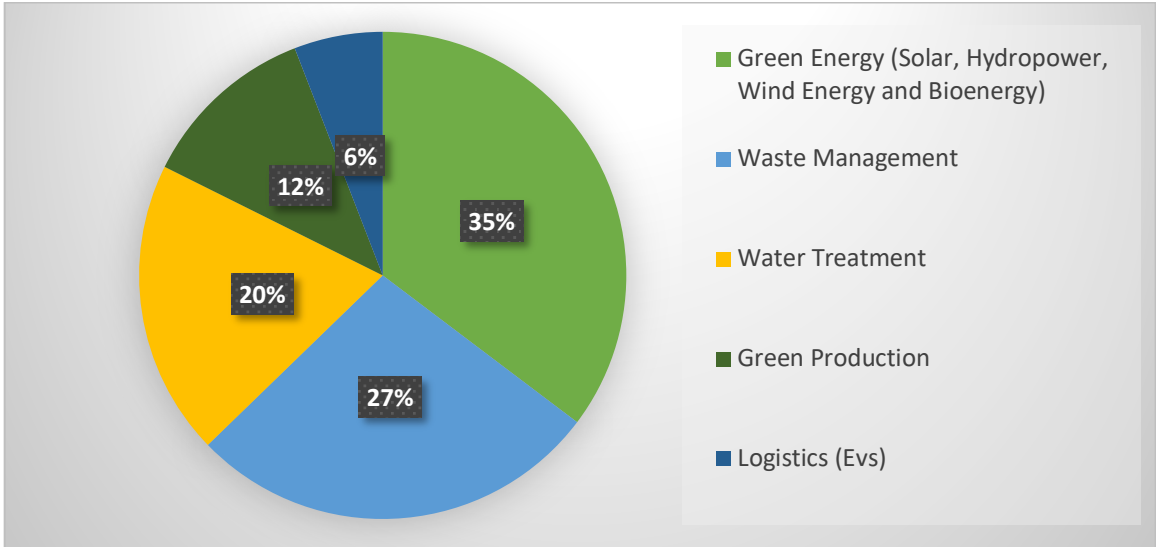
As evidenced by the high level of collaborative research and the growing involvement of academics, this suggests that research in sustainable development is accelerating. Consequently, the industry appears to be evolving significantly and moving forward.

Trend in Global Adoption of Green Technology

Looking at the trend in green technology initiatives, the results of the literature review showed that the most studied component of clean technology is clean energy, which includes research on solar, hydropower, bioenergy, and wind turbines (Figure 3).

Figure 3

Trend Green Technology



Source: Author’s development.

Several earlier studies have identified a substantial possibility of reducing emissions by boosting green energy, with 18 (35%) of the studies researched focusing on clean energy and sustainable development. Most studies on clean energy and sustainable economies focused on the effect of clean

energy (solar, wind turbines, hydropower and bioenergy) on sustainable economic growth across different countries and groups of countries.

There has been a tremendous growth in investment in battery technology, with a 76% increase in 2023. According to Archana et al. (2022), this includes advancements in energy storage systems that enhance the reliability and integration of renewable energy sources. However, advancements have been sluggish and slow in recent years, owing in part to the fact that they involve efforts on the part of several million invested by economic investors worldwide (Harichandan et al., 2022).

Studies on waste management and sustainable development follow this. This constituted 14 (27%) of the research included in this study. As expected, innovative approaches to waste management, such as upcycling and efficient recycling processes, are gaining traction to minimize environmental impact and promote resource efficiency (Wang et al., 2025).

Studies on waste management and sustainable economy have justified the need for green technological innovation, such as waste-to-energy processes (e.g., gasification, pyrolysis), in waste management. Similarly, research in water treatment and sustainable growth is prominent. With 10 (20%) studies reviewed in this category, it is evident that studies on the role of water treatment technologies play a prominent role in green technology and sustainable development research (Ali et al., 2025).

Research on green production technology made up 6 (12%) of the total studies included. This research encompasses environmental sustainability in production and intelligent energy for manufacturing (Vijaya et al., 2024). Finally, 3 (6%) of the research is in green logistics (hydrogen fuel cell) and sustainable development. This highlights how green technology can be applied in blockchain solutions and logistics.

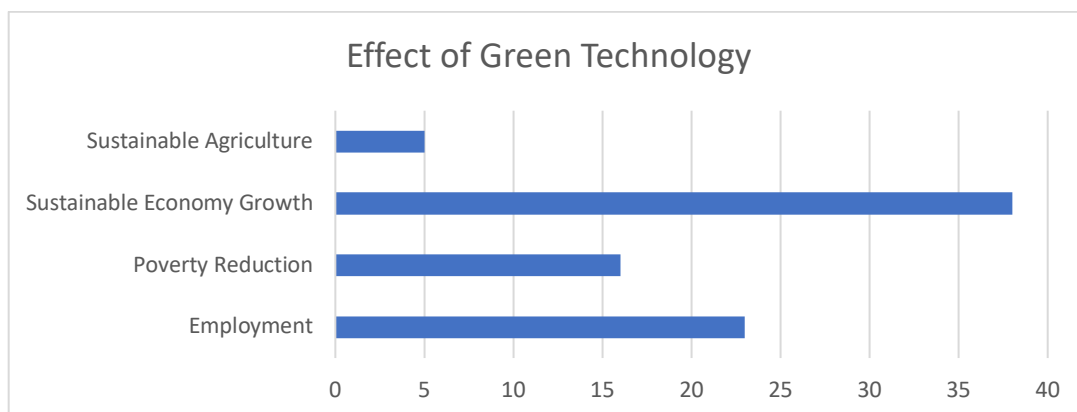
Impact of "green" technologies on key macroeconomic indicators

Green technology is fundamental to economic sustainability. As evident from the studies reviewed, green technology enhances the environment, generates employment, reduces poverty, and facilitates ease of doing business, thereby contributing to sustainable economic growth.

Figure 4 illustrates the conclusions drawn from the reviewed papers regarding the impact of green technology on key economic indicators.

Figure 4

Effect of Green Technology on Key Indicators



Source: Author's development.

All papers studied found that green technology has a positive effect on key economic indicators. Regarding employment generation, 23 of the studies concluded that green technology creates employment, especially in new and emerging sectors.

The rise of renewable energy industries, including solar, wind, and hydro, has led to significant job growth in manufacturing, installation, and maintenance. The electric vehicle (EV) industry has also generated jobs in battery production, charging infrastructure development, and vehicle assembly (De Souza et al., 2021).

Green technology has created a demand for specialized skills, including environmental engineering, sustainable agriculture, and carbon management (Dzikriansyah et al., 2023). Recycling, waste management, and upcycling industries are expanding, creating jobs in materials recovery, waste processing, and product innovation. Sustainable agriculture and food production technologies, such as vertical farming and organic farming, are increasing employment opportunities (Dragomir & Dumitru, 2022). While jobs in traditional sectors may experience short-term downturns, governments and businesses must support skill development and transition programs to ensure a smooth shift in the workforce toward a sustainable economy.

Green technology plays a crucial role in poverty reduction by providing sustainable economic opportunities, improving access to essential resources, and fostering long-term environmental and social well-being (Ali et al., 2025). With 16 papers focusing on the effect of green technology on poverty reduction, these studies found that the expansion of solar, wind, and hydropower industries creates employment opportunities, especially in developing regions where traditional industries are limited. This circular economy fosters new jobs in waste collection, recycling, and upcycling industries, offering livelihoods to low-income communities (Mantaeva et al., 2021).

Water purification technologies and sustainable irrigation practices improve sanitation and the drinking water supply, thereby reducing waterborne diseases in impoverished areas. Green technology promotes food security by optimizing water use, utilizing organic fertilizers, and cultivating climate-resilient crops, ensuring year-round farming practices that help alleviate poverty, especially in developing countries. Additionally, climate-adaptive infrastructure through green innovations helps communities withstand extreme weather events, thereby reducing economic losses from climate-related disasters.

Regarding sustainable agricultural practices, five papers view green technology as a catalyst for agricultural sustainability, promoting innovation, job creation, and sustainability in the agricultural sector (Kumar and Shobana, 2024). Green innovation and technology help manage resource depletion, foster production, and improve growth in the agricultural sector. Green farming techniques enhance productivity, lower costs, and generate employment opportunities in organic farming, precision agriculture, and agroforestry (Alessandri et al., 2024; Singh et al., 2022).

Green technology facilitates energy-efficient production processes, thereby reducing waste and operational expenses. Renewable energy and sustainable infrastructure help protect economies from climate-related disruptions that could adversely affect economic growth (Rehman et al., 2024; Islam et al., 2024). While challenges exist, strategic investments, government incentives, and global cooperation can maximize its economic benefits. Thus, "green technology" can reduce poverty, increase resilience to climate change, generate employment opportunities, foster economic growth, particularly in developing countries, and enhance energy security.

Discussion

Technology for a sustainable economy faces several challenges and barriers, as evident in the various studies included. Implementing sustainable technology can be expensive, which is one of the primary obstacles for small and medium-sized businesses, primarily due to a lack of adequate knowledge regarding the advantages of clean technology. Many potential consumers are reluctant to use these technologies because they are not aware of the possible financial and environmental benefits. Also, new and complicated systems are frequently used in green technologies, which can pose technical difficulties, as also identified by Ahmed and Elfaki (2023).

Installation, maintenance, and interaction with current systems are issues in the adoption of green technologies, especially in countries where technological adoption is still at a lower level. Likewise, regulatory obstacles frequently impede the implementation of green technologies. Lengthy approval procedures, antiquated laws that prioritize conventional technologies, and a dearth of uniform standards for the application of green technology are a few examples (Song et al., 2022; Wani et al., 2024). The adoption of green technology may also be hindered by market uncertainty.

Potential adopters are frequently discouraged by the possibility of innovative technologies becoming outdated, fluctuating pricing for renewable energy, and an unclear return on investment. These obstacles underscore the importance of collaborative efforts to promote the benefits of green technology, provide financial incentives, and engage in research and development to enhance its efficiency and usability.

The fields of academia, governance, planning, and development intervention have all given green technology and the sustainable economy considerable attention. The reason for this is that the majority of the paradigm's supporters and advocates, if not all of them, essentially seem to agree that green technology initiatives can help address the issues facing humanity today, including hunger, deprivation, poverty, inequality, insecurity, water scarcity, ozone layer degradation, climate change, and vegetation loss.

Green technologies, such as efficient logistics, energy systems, and water treatment technologies, among others, are changing the world, and these transitions are radical (Söderholm, 2020). The study found that green technologies create employment through the creation of jobs in sectors related to the production, use and maintenance of clean technologies. For instance, the number of people employed in solar manufacturing, installation, and maintenance is quite substantial. This is similar to the rate of employment in waste management and clean logistics.

Thus, as the adoption of green technologies increases, the potential is that clean technologies would create more employment in new sectors. Moreover, the study's findings indicate that clean technologies can reduce poverty by alleviating the adverse effects of climate change on production and income, especially in developing countries. With a clean environmental system, CO₂ emission is reduced, leaving the ozone layer protected. The implication of this is that farmers and other primary producers are protected from harsh environmental conditions, such as erosion and extreme heat, both of which hurt agricultural activities.

Conclusions and Implications

There is an uneven distribution of research on sustainable development and green technologies. With 35 percent of all the papers analyzed, clean energy received the most attention. The new energy solution, which promotes ecologically friendly energy sources, includes solar, wind turbines, hydropower, and bioenergy. Similarly, clean waste management accounts for 27 percent of the total research studies.

These studies focus on cutting-edge approaches to waste management, including recycling, upcycling, and waste-to-energy technologies, to mitigate the impact of waste. Notably, 20% of the reviewed studies were related to water treatment, a limited resource that is essential to sustainability. The clean production technology accounts for 12% of research articles on clean energy for production and sustainable manufacturing.

Lastly, green logistics, including EVs and green batteries, account for 6% of the research. In essence, it has been determined that green technology is essential to a sustainable global economy. Ultimately, green technology promotes sustainable economic growth by preserving the environment, ensuring sustainable production practices, and generating employment opportunities. In addition to increasing productivity and competitiveness in existing sectors, green technologies also generate new industries and jobs in fields such as waste management, sustainable agriculture, and renewable energy.

Solar manufacturing, installation and maintenance is a new source of employment, especially in developing countries. In terms of growth and output, green technologies stimulate innovation, reduce pollution, and increase resource efficiency, all of which contribute to equitable and sustainable economic development. By improving access to resources, lowering the cost of essential utilities such as energy and water, and generating employment opportunities, green technologies have considerable potential to reduce poverty. Green technology is essential, particularly in areas where environmental problems, such as climate change, exacerbate poverty. Furthermore, sustainable irrigation techniques and water purification enhance food security and cleanliness, which in turn reduce poverty, especially in developing countries.

Notwithstanding its enormous potential to boost economic growth and create sustainable development, green technology faces several obstacles, including high capital requirements, a dearth of sufficient research, a lack of standardization for the adoption of green technologies, and the integration of green technologies into the mainstream economic system. More government assistance and investment in vital areas are expected to alleviate all of these difficulties.

Suggestions for Future Research

Research on the impact of green technologies on a sustainable global economy is still in its early stages. There is a lack of research on poverty alleviation, employment displacement, especially in the traditional sector, and policy incentives.

It is recommended that future research on this subject focus on these areas. Additionally, the majority of studies focus on developed countries, neglecting low-income countries and indigenous knowledge. Therefore, it is expected that researchers addressing issues of green technology integration in developing countries will be at the center of future research.

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Conflict of Interest

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