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The Influence of Environmental Policy, Green Technology, and Ambidextrous Green Innovation on Environmental Performance

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Abstract: The increase in carbon dioxide emissions in Indonesia in recent years shows that environmental performance is still ineffective in balancing economic growth with ecological sustainability. This condition confirms the need for an in-depth study of the factors that influence environmental performance, particularly environmental policy, green technology, and ambidextrous green innovation. This study aims to analyze the influence of these three factors on environmental performance through a *literature review* approach using comparative analysis methods. The data used were obtained from scientific articles, digital books, and academic reports published in the last eight years, obtained from reputable databases such as Scopus, Web of Science, Springer, Taylor & Francis, Emerald, and Google Scholar. The results of the study show that: 1) Environmental policy plays an important role in encouraging regulatory compliance, transparency, and corporate sustainability practices; 2) Green technology has been proven to increase energy efficiency, reduce waste, and lower carbon emissions through the use of renewable energy and environmentally friendly products; and 3) Ambidextrous green innovation contributes to creating a balance between the exploitation of existing green practices and the exploration of new innovations, thereby strengthening the sustainable competitiveness of organizations. This research provides a theoretical contribution by integrating policy, technology, and innovation into a conceptual framework of environmental performance, as well as a practical contribution to organizations and policymakers in designing sustainability strategies.

Keywords: Environmental Performance, Environmental Policy, Green Technology, Ambidextrous Green Innovation

INTRODUCTION

All living things, whether humans, plants, or animals, inhabit various areas on earth that are separated by geographical conditions in the form of land and sea (Kumar, 2022) . In their daily lives, all these creatures depend on the availability of natural resources, ranging from

water and food to energy, which make the earth the only main habitat that supports their survival (Singh, 2024).

However, as human needs increase and development patterns focus solely on economic growth, excessive exploitation of resources has occurred, seriously impacting the balance of ecosystems (Asonye et al., 2021). Phenomena such as air pollution, land degradation, declining water quality, and global climate change are the tangible consequences of environmentally unfriendly activities (Tong & Bambrick, 2022). These conditions not only threaten the preservation of biodiversity but also disrupt human well-being through natural disasters, resource scarcity, and increased health risks (Ali & Rahman, 2024)..

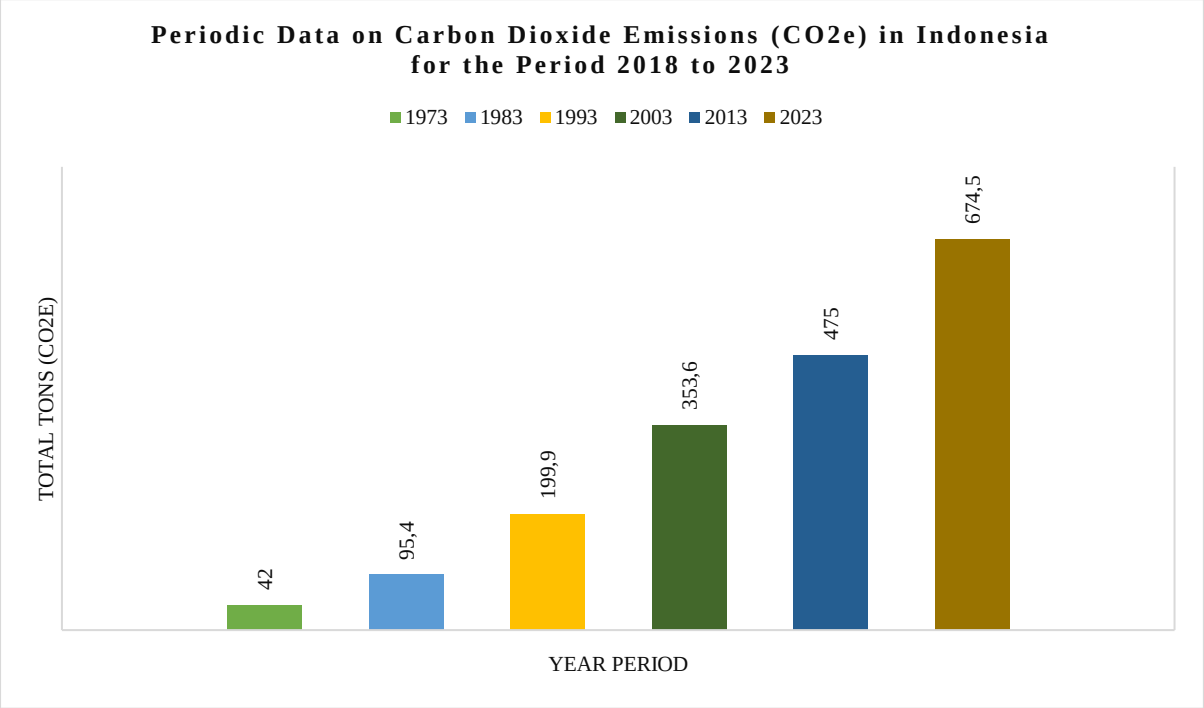

Figure 1. Periodic Carbon Dioxide (CO2) Emission Data in Indonesia from 2018 to 2023
Source:(Shabibah. A, 2025)

Figure 1, which displays periodic data on carbon dioxide (CO_2) emissions in Indonesia from 2018 to 2023, illustrates important dynamics that are directly related to the urgency of this research. Carbon dioxide is one of the main greenhouse gases that contributes significantly to global climate change (Cahyo et al., 2023). CO_2 emission trends in Indonesia over the past six years show a fluctuating tendency with an upward pattern, although there were declines during certain periods due to a slowdown in economic activity, such as that caused by the COVID-19 pandemic. However, after 2020, emissions rose again in line with the national economic recovery and increased industrial activity, transportation, and fossil fuel use (Wahyono et al., 2024). This fact shows that sustainable development in Indonesia still faces major challenges in balancing energy needs and economic growth with the commitment to reduce carbon emissions (Idroes et al., 2023).

The relevance of this data to the research title, namely *"The Effect of Environmental Policy, Green Technology, and Ambidextrous Green Innovation on Environmental Performance,"* is very significant. High CO_2 emission levels reflect low environmental performance effectiveness that is not yet optimal. Therefore, the variables raised in this study have the potential to contribute to reducing emissions. For example, strict environmental policies can encourage companies to reduce their dependence on fossil fuels and switch to renewable energy sources (X. Wang et al., 2021). Similarly, the application of green

technology in the industrial and transportation sectors can improve energy efficiency and minimize resource waste. Meanwhile, ambidextrous green innovation provides opportunities for organizations to not only exploit existing environmentally friendly technologies, but also explore new innovations that can radically reduce carbon emissions (Barazanchi & Rasheed, 2024).

Furthermore, the data in Figure 1 also confirms the importance of the relationship between theory and empirical reality. Increasing CO_2 emissions are clear evidence that despite existing environmental policies, regulations, and initiatives, implementation in the field still faces obstacles, whether in terms of technology, funding, or institutional commitment (Xian et al., 2024). This is where the urgency of this research lies, namely to explain how environmental policies, green technology, and ambidextrous green innovation can synergize to improve environmental performance (Thi & Do, 2024). In other words, this research seeks to provide conceptual and practical answers to the issues described by CO_2 emission trends.

In addition, this figure also serves as a basis for justifying why research on environmental performance is very important. If the trend of rising CO_2 emissions is not immediately controlled through appropriate policy approaches and innovations, Indonesia risks failing to achieve the carbon emission reduction targets set out in international commitments such as the Paris Agreement (Hasyim et al., 2024). In this context, the integration of research variables is a strategic solution. Environmental policy acts as a regulatory umbrella, green technology as a practical instrument, and ambidextrous green innovation as a driving force for adaptation and sustainable transformation (Setiawan et al., 2024).

Thus, Figure 1 not only serves as supporting data, but also as confirmation of the main argument of the study. CO_2 emission data in Indonesia for the period 2018–2023 confirms that there is a real and urgent problem, and reinforces the rationale for conducting studies on environmental policy, green technology, and ambidextrous green innovation on environmental performance. This article, with the conceptual framework it offers, seeks to contribute to a more systematic solution in addressing the challenge of improving environmental performance in Indonesia.

Problem Formulation

Based on the background of the problem above, the problem formulation in this literature review study is as follows: 1) Does environmental policy affect environmental performance?; 2) Does green technology affect environmental performance?; and 3) Does ambidextrous green innovation affect environmental performance?

METHOD

This study uses a descriptive qualitative approach with a literature review method. This approach was chosen because it is suitable for investigating and understanding the characteristics of factors that influence environmental performance based on previous research results. Literature review not only presents a summary of previous findings, but also conducts critical analysis and synthesis to identify similarities, differences, and patterns of relationships between variables. Through this approach, researchers are able to develop stronger, evidence-based theoretical arguments, thereby contributing to the enrichment of academic studies in the field of environmental management and sustainability (Boulton, M. J., & Houghton, 2021).

The research data was sourced from secondary data obtained from journal articles, digital books, and academic reports relevant to the variables of environmental policy, green technology, ambidextrous green innovation, and environmental performance. The criteria for selecting the literature were publications issued within the last eight years, so that they could represent the latest developments in this field. The literature sources came from various reputable academic databases, such as Thomson Reuters, Scopus, Taylor & Francis, Emerald,

Sage, Springer, Web of Science, Elsevier, DOAJ, EBSCO, and additional searches through Google Scholar, (P. C. Susanto et al., 2024).

The data collection process was conducted through a systematic literature review. Researchers selected literature based on keywords relevant to the research variables, such as *environmental performance, environmental policy, green technology, and ambidextrous green innovation*. Articles that met the inclusion criteria were further filtered by reading the title, abstract, methodology, and research results to ensure relevance. The selected literature was then reviewed in depth to extract important information related to conceptual models, relationships between variables, and empirical findings that supported the research argument (Azhari et al., 2023).

Data analysis was conducted using comparative analysis, a method that emphasizes comparing previous research results to find similarities, differences, and relationships between variables. The analysis stages included data reduction through the selection of appropriate literature, presentation of data in the form of tables from previous research to facilitate comparison, and drawing conclusions based on a synthesis of findings. With this approach, researchers can gain a comprehensive understanding of the influence of environmental policies, green technology, and ambidextrous green innovation on environmental performance. The validity of the data is strengthened by the use of various reputable international and cross-context literature sources, so that the analysis results are academically accountable (Dewi, 2024).

RESULTS AND DISCUSSION

Based on the problem background and problem formulation above, the literature review in this study is as follows:

Environmental Performance

Environmental performance is a description of the level of success of an organization, institution, or company in managing its activities so as to minimize negative impacts on the environment and maximize positive contributions to sustainability. This concept covers the extent to which companies are able to integrate environmentally friendly principles into their management systems, production processes, and services provided (Li et al., 2020).

Indicators or dimensions included in environmental performance variables are: 1) Waste Management: Includes the company's efforts to reduce, process, and recycle solid and liquid waste so as not to pollute the environment; 2) Energy Efficiency: The organization's ability to reduce energy use through energy-saving technologies or efficient work practices; 3) Emission Control: Reduction of air pollution, greenhouse gases, and other hazardous substances released into the environment; 4) Regulatory Compliance: Level of compliance with environmental regulations, standards, and certifications such as ISO 14001 or relevant government regulations (Gephart et al., 2021).

Environmental performance variables are relevant to previous studies conducted by: (S. U. Rehman et al., 2021), (Cao et al., 2021), (Q.-J. Wang et al., 2022).

Environmental Policy

Environmental policy is a set of rules, guidelines, and commitments developed by organizations and governments to regulate, control, and direct human activities so that they do not damage the environment and continue to support sustainable development. In a company, environmental policy reflects management's commitment to implementing sustainability principles, which are usually outlined in official documents and form the basis for the implementation of various environmental programs (Arvidsson & Dumay, 2022).

The indicators or dimensions contained in the environmental policy variable include: 1) Management Commitment: Tangible support from leaders in formulating and implementing environmentally friendly policies; 2) Documentation and Transparency: The existence of official environmental policy documents that are published and communicated to stakeholders; 3) Integration into Strategy: The extent to which environmental policy is part of the company's business strategy; 4) Evaluation and Improvement: Mechanisms for monitoring, auditing, and periodically updating policies to keep pace with regulatory developments and needs (Spaargaren, 2020).

Environmental policy variables are relevant to previous studies conducted by: (Yirong, 2022), (Divan & Rosencranz, 2022), (Zheng et al., 2022).

Green Technology

Green technology is the application of science and technological innovation designed to reduce negative impacts on the environment, improve resource efficiency, and support sustainable development. This technology encompasses various forms of applications, ranging from renewable energy such as solar, wind, and biomass, to waste treatment, recycling, and environmentally friendly product design. The concept of green technology not only focuses on technical aspects but also involves principles of economic and social efficiency (Feng et al., 2022).

Indicators or dimensions included in the green technology variable are: 1) Renewable Energy: Use of environmentally friendly energy sources such as solar, wind, or biomass; 2) Resource Efficiency: Application of technology to save raw materials, water, and energy in the production process; 3) Processing and Recycling: Technologies that support waste reduction through recycling or reuse of production waste materials; 4) Environmentally Friendly Products: Innovations in product design to make products safer, more durable, and biodegradable without harming the environment (Bradu et al., 2022).

Green technology variables are relevant to previous research conducted by: (Mugoni et al., 2023), (Shan et al., 2021), (Bilal et al., 2021), (Sahoo et al., 2023).

Ambidextrous Green Innovation

Ambidextrous green innovation is an organization's ability to balance two green innovation orientations simultaneously, namely exploitation and exploration, in order to achieve sustainable excellence in environmental performance. Exploitation refers to the use of existing resources and technologies to improve efficiency, reduce waste, and improve production processes to be more environmentally friendly (Asiaei et al., 2023).

The indicators or dimensions contained in the ambidextrous green innovation variable include: 1) Green Exploitation: Optimization of existing environmentally friendly technologies and practices to improve efficiency; 2) Green Exploration: Search and development of new ideas, products, or technologies that are environmentally oriented; 3) Organizational Flexibility: The ability of companies to balance the use of old technologies with the adaptive application of new innovations; 4) Green Competitive Advantage: Achieving long-term competitiveness through a combination of sustainable exploration and exploitation innovations (Shehzad et al., 2023).

The ambidextrous green innovation variables are relevant to previous studies conducted by: (Cheng et al., 2025), (Kamran et al., 2025), (Javed et al., 2025).

Previous Research

Based on the above findings and previous studies, the research discussion is formulated as follows:

Table 1. Relevant Previous Research Findings

No	Author (Year)	Research Findings	Similarities With This Article	Differences With This Article	Hypothesis
1	(Xiang et al., 2022)	Government environmental policy variables affect the environmental performance of small and medium-sized enterprises in China	This article is similar in that it examines environmental policy variables as independent variables and environmental performance variables as dependent variables.	The difference from previous studies is that the object of this study is Chinese SMEs.	H1
2	(Sahoo et al., 2023)	-The green knowledge management variable affects environmental performance - The green technology variable affects environmental performance	This article is similar in that it examines the green technology variable as an independent variable and the environmental performance variable as a dependent variable.	The difference from previous studies lies in the inclusion of green knowledge management as another independent variable.	H2
3	(Asiaei et al., 2023)	-The green intellectual capital variable affects environmental performance -The ambidextrous green innovation variable affects environmental performance	This article is similar in that it examines the ambidextrous green innovation variable as an independent variable and examines the environmental performance variable as a dependent variable	The difference from previous studies lies in the inclusion of green intellectual capital as another independent variable.	H3

Discussion

Based on the research questions and relevant previous studies, the discussion in this literature review is as follows:

1. The Effect of Environmental Policy on Environmental Performance

Based on a review of the literature and relevant previous studies, it can be stated that environmental policy has an impact on environmental performance.

To improve environmental performance through environmental policy, every company or organization must do the following: 1) Management commitment: Environmental policy must originate from top management and be fully supported by them. This means that management must allocate adequate resources (financial, human, and technological) for the implementation of environmental programs. This commitment is manifested through the establishment of clear and measurable environmental goals and targets, as well as ensuring that all employees understand and are responsible for these environmental policies; 2) Documentation and transparency: Companies must have a documented environmental management system (EMS) that includes standard operating procedures, identification of environmental aspects, and recording of all performance data. Transparency involves the regular disclosure of environmental performance to stakeholders, either through sustainability reports (such as those based on GRI) or mandatory government reporting (such as PROPER).

Then, after implementing management commitment, documentation, and transparency, the following must be done: 1) Integration into strategy: This means that environmental considerations are not viewed as a separate function, but are embedded in all business decisions and core operational processes; and 2) Evaluation and improvement: Companies must regularly measure, monitor, and analyze their Environmental Performance against set targets. This includes conducting periodic internal audits, reviewing policy compliance, and identifying areas for improvement.

If every company or organization can provide or pay attention to management commitment, documentation and transparency, integration in strategy, evaluation and improvement, it will have a positive effect on environmental performance, including: 1) Waste management: The implementation of strict environmental policies encourages companies to manage waste disposal, which was previously done conventionally. This triggers the adoption of a tiered waste management strategy, starting with waste reduction at the source, followed by *reuse* and *recycling*; 2) Energy efficiency: Integration into business strategy encourages changes in operational behavior, such as optimizing production schedules and improving facility insulation; 3) Emission control: Strong environmental policies force companies to implement advanced mitigation technologies, such as filters, *scrubbers*, and *catalytic converters* in production processes. In addition, a commitment to transparency encourages accurate measurement and reporting of emissions; and 4) Regulatory compliance: Through good documentation and regular evaluation, companies can proactively identify and address potential compliance risks. Consistent and proven compliance (e.g., through good PROPER ratings) reduces legal and penalty risks, maintains the company's image, and strengthens good relationships with the government and stakeholders. Furthermore, companies often use Environmental Policy to go *beyond compliance*, voluntarily setting higher standards.

The results of this study are in line with previous research conducted by (Xiang et al., 2022), which states that there is an influence between environmental policy and environmental performance.

2. The Influence of Green Technology on Environmental Performance

Based on a literature review and relevant previous studies, it is stated that green technology has an impact on environmental performance.

To improve environmental performance through green technology, every company or organization must do the following: 1) Renewable energy: By integrating renewable energy systems, companies directly reduce their dependence on coal or gas, which are major contributors to greenhouse gas emissions; 2) Resource efficiency: Resource efficiency focuses on the optimal use of inputs (water, raw materials, energy) to produce the same or more output. This is achieved through the adoption of *cleaner production* technologies, *smart metering* systems, and the reuse of water in closed cycles; 3) Treatment and recycling: Treatment and recycling refer to the application of advanced technologies to process solid and liquid waste. This includes investment in wastewater treatment facilities capable of effectively removing pollutants before disposal, as well as material recycling technologies that convert waste into valuable secondary raw materials; 4) Environmentally friendly products: Environmentally Friendly Products involve the use *of eco-design* technologies to develop products that have minimal environmental impact throughout their life cycle, from raw material extraction to final disposal.

If every company or organization can provide or pay attention to renewable energy, resource efficiency, processing and recycling, and the use of environmentally friendly products, it will have a positive impact on environmental performance, including: 1) Waste management: Companies are able to reduce the volume of solid and liquid waste disposed of into the environment through modern recycling and processing systems; 2) Energy efficiency: Green technology encourages the use of energy-efficient machines, LED lighting, and more power-efficient production systems; 3) Emission control: ; and 4) Regulatory compliance: Investment in these four areas of green technology serves as a proactive mechanism to ensure regulatory compliance. By voluntarily exceeding compliance standards (such as emission limits and waste treatment standards) through superior technology, companies minimize the risk of future violations, reduce potential fines, and build a solid reputation in the eyes of regulators and the public.

The results of this study are in line with previous studies conducted by (Sahoo et al., 2023), (Du et al., 2023), (Cao et al., 2021), which state that there is an influence between green technology and environmental performance.

3. The Influence of Ambidextrous Green Innovation on Environmental Performance

Based on a literature review and relevant previous research, it is stated that ambidextrous green innovation influences environmental performance.

To improve environmental performance through ambidextrous green innovation, every company or organization must do the following: 1) Green exploitation: This includes optimizing existing resources, technologies, and environmentally friendly practices so that companies can improve efficiency in the production process while reducing waste. 2) Green exploration: Companies need to emphasize the development of new ideas, technologies, and approaches in creating more sustainable products or processes, thereby supporting the creation of innovative solutions to environmental challenges; 3) Organizational flexibility: This is an important factor because it allows companies to balance the stability of using old technology with the application of new, more environmentally friendly technology; and 4) Green competitive advantage: Companies need to utilize green innovation to create added value, a positive reputation, and sustainable competitiveness.

If every company or organization can provide or pay attention to green exploitation, green exploration, organizational flexibility, and green competitive advantage, it will have a positive effect on environmental performance, including: 1) Waste management: The combination of Exploitation (reducing current process residues) and Exploration (creating raw materials that are fully recyclable or *biodegradable)* ensures that Waste Management moves towards a circular economy and *zero waste* model. Hazardous waste is reduced, and non-hazardous waste is maximized for resource recovery; 2) Energy efficiency: Exploration encourages investment in radical renewable energy (e.g., internal *smart grids*, advanced cogeneration systems) that can fundamentally change a company's energy mix, significantly reducing energy intensity per unit of production; 3) Emissions control: Exploration invests in carbon capture and utilization (CCUS) technologies or the development of non-carbon fuels/processes, enabling companies to achieve carbon neutrality or even carbon negativity in the future; and 4) Regulatory compliance: Ambidextrous Green Innovation takes companies *beyond compliance*. Exploitation ensures perfect compliance with applicable regulations, minimizing fines and risks. Exploration puts companies at the forefront of environmental technology, anticipating and exceeding expected regulatory standards, making them trusted partners for regulators and stakeholders.

The results of this study are in line with previous studies conducted by (Asiaei et al., 2023), (Zhang et al., 2020), (Baquero, 2024), which state that there is an influence between ambidextrous green innovation and environmental performance.

Conceptual Framework

The conceptual framework is determined based on the research problem, research objectives, and previous studies relevant to the literature review:

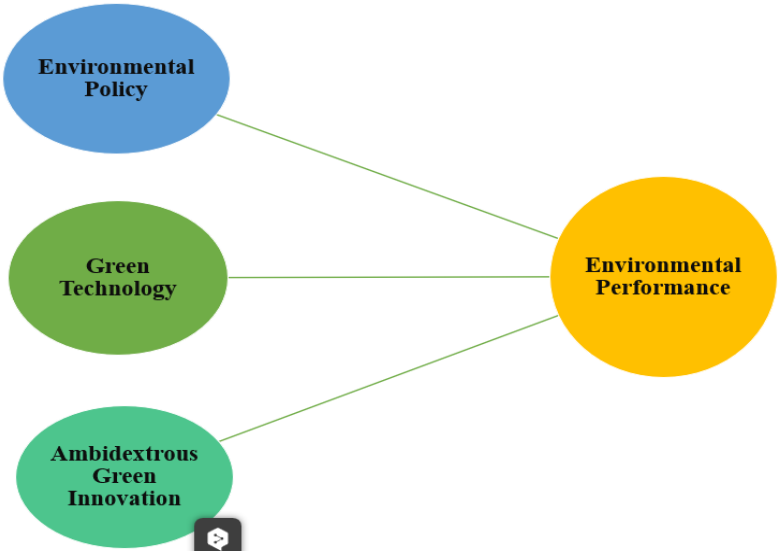

Figure 2. Conceptual Framework

Based on Figure 2 above, environmental policy, green technology, and ambidextrous green innovation influence environmental performance. However, in addition to the variables of environmental policy, green technology, and ambidextrous green innovation that influence environmental performance, there are other variables that influence it, including:

1) Green Organizational Culture: (A. Susanto, 2023), (Prakosa & Wajdi, 2024), (Abbas & Khan, 2023), (Hastuti & Muafi, 2022).
2) Green Human Resources: (Zhao & Huang, 2022), (Ly, 2023), (Aboramadan, 2022), (Bangura et al., 2024).
3) Green Leadership: (Tosun et al., 2022), (Noor et al., 2023), (A. Rehman & Yaqub, 2021), (Özgül & Zehir, 2023).

CONCLUSION

Based on the research question, results, and discussion above, the conclusion of this literature review study is as follows:

1) Environmental policies influence environmental performance. Clear, consistent, and integrated policies within organizational strategies enable companies to better comply with regulations, reduce the negative impacts of operational activities, and improve sustainability practices.
2) Green technology affects environmental performance; the application of renewable energy-based technology, resource efficiency, waste treatment, and environmentally friendly product innovation has been proven to reduce emissions, save energy, and minimize ecosystem damage.
3) Ambidextrous green innovation affects environmental performance, as the ability of organizations to balance the exploitation of existing green technologies with the exploration of new innovations encourages the creation of sustainable efficiency, pollution control, and increased sustainability-based competitiveness.

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