



Legal Challenges in the Development of Green AI to Support Indonesia's National and International Commitments to Sustainable Technology

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ABSTRACT

Green AI has great potential in supporting sustainability efforts through the application of environmentally friendly technologies that can reduce energy consumption and carbon emissions. However, legal arrangements related to the development of Green AI in Indonesia are still limited, despite the urgency to integrate AI in the sustainable technology ecosystem. Environmental protection through Green AI policy requires a clear and in-depth legal framework to ensure the contribution of this technology to sustainability goals. This research aims to analyze the legal and policy challenges needed to support the development of Green AI in Indonesia. The method used in this research is juridical-normative research, by analyzing secondary data from primary, secondary, and tertiary legal materials. The results show that Green AI has great potential to support sustainability in Indonesia, but is hampered by the lack of specific regulations. The government needs to develop policies that include operational standards, green certification, and incentives for companies that adopt green technologies. Concrete steps such as accelerating licensing, supporting research, and encouraging public-private sector collaboration will significantly increase the practical impact of Green AI.



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INTRODUCTION

The development of Artificial Intelligence (AI) technology has significantly impacted various sectors, ranging from industry, transportation, to energy. However, this progress also brings environmental consequences that cannot be ignored, particularly concerning the high energy consumption required to operate AI systems. Therefore, there is an urgent need to develop Green AI, which is AI designed and implemented with a focus on environmental sustainability. Green AI emphasizes reducing carbon footprints and optimizing the use of renewable energy to minimize its negative impact on the environment (Alzoubi & Mishra, 2024).

Globally, the awareness of the importance of environmentally friendly technology aligns with the objectives of the Sustainable Development Goals (SDGs), particularly Goal 7 (affordable and clean energy) and Goal 13 (climate action) (UN, 2017). Several developed countries, such as the United States, Germany, and Japan, have taken significant steps in advancing Green AI by implementing policies that encourage low-emission technological innovation and support the use of clean energy in AI operations (Cicerone et al., 2023). For instance, major technology companies like Google and Microsoft have committed to using renewable energy for their data centers and designing AI systems that are more energy-efficient (Laila, 2024).

In Indonesia, efforts to adopt Green AI are still in their early stages. Some examples of Green AI applications can be found in the energy sector, such as the use of AI to monitor and optimize renewable energy-based electricity grids. PT PLN, for example, has begun utilizing AI technology to improve efficiency in the distribution of electricity from renewable energy sources (Muhammad, 2023). However, significant legal challenges remain. At present, Indonesia lacks specific regulations governing the use of Green AI and how this technology can be integrated into national environmental policies.

From a legal perspective, Indonesia has several legal frameworks that can serve as a foundation for the development of Green AI, such as Law No. 32 of 2009 on Environmental Protection and Management and Presidential Regulation No. 22 of 2017 on the National Energy General Plan (RUEN). However, these existing regulations are not yet fully responsive to the rapid development of AI technology and have not anticipated the environmental impacts of such technology. This creates a legal gap that necessitates either the revision of existing regulations or the creation of new, more comprehensive legal frameworks.

At the international level, Indonesia has committed to the 2015 Paris Agreement to reduce greenhouse gas emissions and the implementation of the SDGs (JRE, 2021). Nevertheless, significant challenges arise in linking these commitments to technological advancements. Technologies such as Green AI require policies that explicitly support environmentally friendly innovations, especially in terms of reducing emissions from the technological infrastructure used, such as data centers and servers (Alzoubi & Mishra, 2024).

Another challenge in the development of Green AI in Indonesia is the lack of coordination among various relevant sectors, including energy, technology, and the environment. Additionally, ethical issues surrounding the use of AI also require attention, particularly concerning the responsibility to mitigate environmental impacts and the protection of data and privacy related to large-scale AI use (Das et al., 2015).

The rapid technological advancements in AI are outpacing the ability of existing legal frameworks to regulate and manage the environmental impacts associated with them. These gaps include a lack of clear guidelines on integrating Green AI principles into national laws and insufficient legal instruments to incentivize companies and industries to adopt sustainable practices in AI development. Moreover, without a coherent legal response, Indonesia risks falling behind in global efforts to implement technologies that are not only advanced but also sustainable. Addressing these legal gaps will not only support Indonesia's national commitments to reducing greenhouse gas emissions but also align its technological progress with international standards and agreements on climate action and sustainability. By bridging these gaps, Indonesia can create a legal environment that fosters innovation while ensuring that Green AI contributes to a sustainable, low-emission future.

While Green AI has some legal challenges, it also has potential that needs to be maximized. Given the significant potential of Green AI to support a sustainable technology ecosystem in Indonesia, it is time for appropriate legal measures to be taken. These measures include the formulation of new regulations governing the development and implementation of Green AI, as well as the revision of existing policies to support the use of renewable energy and energy efficiency in AI technologies (Imaz & Sheinbaum, 2017). Thus, Indonesia can leverage this technology as an innovative solution to address climate change challenges while promoting sustainable technological transformation.

The issues that will be explicitly discussed in this research include the various legal challenges faced in developing Green AI in Indonesia, identifying gaps in the current regulations, and proposing policy recommendations that can help realize a sustainable, environmentally friendly technology ecosystem.

RESEARCH METHODS

This type of research is juridical-normative. Normative juridical research is research conducted by examining library materials or secondary data (Quddus, 2024). The use of secondary data through normative juridical research is particularly appropriate as it focuses on examining

existing laws and regulations, which is critical in understanding the current legal landscape surrounding Green AI in Indonesia. This research will examine problems related to the absence of clear legal arrangements related to the development of Green AI to realize a sustainable technology ecosystem in Indonesia.

The Data Analysis Method will be carried out by collecting secondary data through a review of library materials which include legal materials, both primary, namely Law No. 32 of 2009 concerning Environmental Protection and Management, Presidential Regulation No. 22 of 2017 concerning the National Energy General Plan (RUEN), the 2015 Paris Agreement to reduce greenhouse gas emissions, and the SDGs. Secondary Legal Materials are legal materials that explain primary legal materials, namely books, journals, research reports, magazines, articles, and documents related to the research theme. Tertiary Legal Materials, are legal materials that complement primary and secondary legal materials, namely: Legal Dictionary, Indonesian Dictionary, and English Dictionary. Reviewing primary, secondary, and tertiary legal materials allows for a comprehensive and in-depth analysis of the legal framework that may support or hinder the development of Green AI. By relying on multiple legal sources, the research was able to identify potential inconsistencies or gaps in the law that may not be immediately apparent in a more focused study.

The secondary data collection method is carried out by document study. After the data is collected, the data analysis used is qualitative data analysis. Qualitative data analysis is applied to find and describe problems in the field or structures and processes in routines and practices (Putranti & Putri, 2024). Qualitative data analysis ensures that the findings of this research are not only descriptive, but also provide a deeper understanding of the underlying legal structures and processes that influence the integration of Green AI in Indonesia's technology and environmental policies. This methodology will be particularly useful in proposing actionable legal reforms and policy recommendations that are grounded in legal theory and practical implications.

RESULTS AND DISCUSSION

Green AI in Realizing a Sustainable Technology Ecosystem

The concept of Green AI is increasingly significant to be implemented, considering the crucial role of Artificial Intelligence (AI) in human life and the urgent need for technological solutions that are not only advanced but also environmentally friendly. AI refers to technologies that enable machines and systems to simulate human intelligence, process information, and make decisions based on the data they receive (Schwartz et al., 2020). AI is employed across various sectors such as healthcare, industry, transportation, and energy to enhance efficiency and output automatically (Jarvis, 2020).

As the usage of AI expands, there is growing awareness of the substantial environmental impact this technology can have. AI demands vast computational power, which in turn consumes large amounts of energy. A study from the University of Massachusetts found that training a deep learning-based AI model could produce carbon emissions equivalent to a transatlantic flight (Cicerone et al., 2023). Green AI, therefore, emerges as a solution to address this issue. It refers to the development and implementation of AI with an emphasis on energy efficiency and the reduction of negative environmental impacts (Jorzik et al., 2024). Its primary focus is on minimizing the carbon footprint of AI usage and harnessing more sustainable energy resources.

In the context of a sustainable technology ecosystem, sustainable technology refers to the development and deployment of technologies that meet present human needs without compromising the ability of future generations to meet their own needs. Sustainable technology considers aspects of resource efficiency, waste reduction, and minimal negative environmental impact (Sui & Yao, 2023). The transformation toward sustainable technology is critical due to the global threats posed by climate change, resource depletion, and environmental degradation. According to the IPCC (Intergovernmental Panel on Climate Change) report, the world must drastically reduce greenhouse gas emissions within this decade to prevent the most severe effects of climate change (Levvin, 2022).

Therefore, technologies that contribute to sustainability, such as Green AI, play a key role in achieving this target.

Globally, the Sustainable Development Goals (SDGs) emphasize the importance of environmentally friendly technology, particularly in Goal 7 (affordable and clean energy) and Goal 13 (climate action) (UN, 2017). The SDGs serve as an international guide for countries in transforming toward sustainability, including the development of technology. Many developed countries have already begun implementing policies related to sustainable technology, including the use of Green AI (Xue et al., 2022). For example, Google has committed to operating entirely on renewable energy, while Microsoft has launched the AI for Earth initiative, which supports AI solutions for environmental problems (Laila, 2024).

In Indonesia, the use of Green AI is still in its early stages, though it holds significant potential. Indonesia faces challenges in meeting its carbon emission reduction targets set in the 2015 Paris Agreement, where it committed to reducing greenhouse gas emissions by 29% by 2030 (JRE, 2021). The application of Green AI could serve as a solution to achieve this target, particularly in the energy and industrial sectors. One example of Green AI implementation in Indonesia is PT PLN's efforts to improve the efficiency of its renewable energy-based electricity grid using AI technology (Muhammad, 2023). This initiative supports the transition to clean energy and helps reduce Indonesia's reliance on fossil fuels, which are harmful to the environment.

The benefits of Green AI in achieving a sustainable technology ecosystem are extensive. First, Green AI can help significantly reduce energy consumption by optimizing computational processes (Alzoubi & Mishra, 2024). AI can be used to decrease energy usage in data centers, which are known to be one of the largest sources of carbon emissions in the digital world. Green AI can also be applied in energy management, where AI monitors and optimizes energy use across sectors, thereby increasing energy efficiency and reducing waste. In the manufacturing industry, Green AI can be employed to develop more environmentally friendly production systems by minimizing waste and optimizing supply chains.

In Indonesia, Green AI can offer strategic benefits for environmental sustainability and economic development (Schwartz et al., 2020). With abundant renewable energy resources, such as solar and wind power, AI can be utilized to integrate and optimize the use of renewable energy in the national electricity grid. Additionally, Green AI can play a role in addressing deforestation and land degradation issues by utilizing AI in satellite monitoring and environmental data analysis to manage forests and land more effectively (Xue et al., 2022).

Given its vast potential and benefits, Green AI becomes a key factor in creating a sustainable and environmentally friendly technology ecosystem. To realize this, collaborative efforts between the government, private sector, and academia are required to develop policies, infrastructure, and innovations that support the use of AI that is not only intelligent but also mindful of environmental sustainability.

Legal Challenges in Supporting Green AI Development

The legal challenges in supporting the development of Green AI in Indonesia have become an increasingly important issue as artificial intelligence (AI) technology, which has a significant environmental impact, continues to advance. Green AI, as an innovation within artificial intelligence designed to reduce carbon footprints and excessive energy consumption, holds significant potential in fostering the creation of a sustainable technology ecosystem. However, in Indonesia, regulations governing the development and use of Green AI are still minimal. This technology has not yet received adequate attention within the existing legal framework, including Law No. 32 of 2009 on Environmental Protection and Management (UUPLH) and Presidential Regulation No. 22 of 2017 on the National Energy Policy (RUEN). This presents substantial challenges to the development of Green AI, both in terms of policy and implementation.

The operational challenges of implementing Green AI extend beyond the legal landscape. These challenges include issues such as the technological limitations of current AI systems, the lack of proper infrastructure to support energy-efficient AI applications, and the need for extensive

financial investments. Additionally, companies involved in AI development face pressure to balance environmental sustainability with the rapid pace of technological advancements, which often come with high resource consumption.

First, it is essential to recognize that regulations governing AI in general are unclear in Indonesia. To date, there is no specific law regulating the use of AI, let alone Green AI, in the context of environmentally friendly technology. This lack of regulation leads to legal uncertainty for industry players who wish to develop and implement energy efficient AI. AI is increasingly being used in various sectors, such as energy, transportation, and industry, all of which have a significant environmental impact. In this regard, the government's role is crucial in designing a regulatory framework that encourages the development of environmentally friendly technologies such as Green AI, while also protecting environmental interests in line with sustainability principles.

Another layer of complexity arises from the ethical considerations surrounding Green AI. The application of AI technologies designed to reduce environmental impact must be aligned with ethical principles that consider not only the technological feasibility but also the potential consequences for society at large. Ethical concerns related to data privacy, transparency in AI decision-making, and accountability for AI's environmental impact must be fully integrated into the regulatory framework.

Law No. 32 of 2009 on Environmental Protection and Management provides a relevant legal framework for protecting the environment from the negative impacts of technology; however, it does not specifically address the implementation of Green AI (Indonesia, 2009). UUPH contains several provisions that can be interpreted as a legal basis for regulating environmentally friendly technologies, but it does not explicitly cover technological aspects such as Green AI. Article 3, for example, states that the goal of environmental management is to achieve environmentally sound sustainable development. Meanwhile, Article 13 obliges the government and regional governments to formulate policies for environmental protection and management. However, there are no specific provisions regulating the use of advanced technologies that could support these objectives, such as AI focused on energy efficiency and carbon footprint reduction.

Furthermore, Article 43 of UUPH mandates that every business activity must minimize negative environmental impacts. In this context, companies that use AI in their operations could be required to minimize the environmental impacts of the technologies they use, including high energy consumption. Nevertheless, more specific regulations are needed to ensure that companies utilizing AI have clear guidelines on how such technologies can be implemented in an environmentally responsible manner.

In addition to UUPH, Presidential Regulation No. 22 of 2017 on the National Energy Policy (RUEN) is also relevant in supporting the development of Green AI (Indonesia, 2017). RUEN aims to promote the use of renewable energy to achieve Indonesia's energy mix target, in which renewable energy must account for 23% of total national energy by 2025 (ESDM, 2021). However, RUEN does not explicitly mention the role of technologies such as AI in optimizing the use of renewable energy. Yet, AI, especially Green AI, has significant potential to support this goal through the optimization of more efficient energy systems. For instance, AI can be used to monitor and manage renewable energy distribution in real-time, reducing waste and enhancing the efficiency of the national energy system.

Another legal challenge arises from the lack of clarity regarding legal responsibility in the use of Green AI. In the development of AI technologies, including Green AI, legal responsibility and ethical aspects play a crucial role (Khanzode, n.d.,2022). The misuse or irresponsible application of AI can lead to significant problems, both environmentally and socially. For example, if a technology company uses AI that is not environmentally friendly or fails to adhere to sustainability principles, who will be held accountable for the damage caused? In this case, clear regulations are required to establish legal responsibility for technology developers and companies that use AI.

The ethical and operational challenges of Green AI must be examined within a broader framework that integrates legal norms with international commitments. This includes aligning Green AI development with the Paris Agreement and the Sustainable Development Goals (SDGs), which emphasize technological innovation in the service of environmental sustainability. Indonesia must

adopt legal frameworks that account for both the technological and ethical dimensions of Green AI, fostering a balanced approach that promotes sustainable innovation while safeguarding environmental and societal interests.

At the international level, the 2015 Paris Agreement and the Sustainable Development Goals (SDGs) have emphasized the importance of technology transformation in supporting environmental sustainability. Indonesia, as one of the countries committed to these agreements, must be capable of adopting environmentally friendly technologies such as Green AI across various sectors. However, without a clear and supportive legal framework, the development of these technologies will face significant obstacles. Existing regulations, such as UUPLH and RUEN, need to be revised or supplemented with more specific provisions regarding the use of Green AI and other environmentally friendly technologies.

In the renewable energy sector Green AI can make a significant contribution. AI designed with sustainability principles can help manage solar or wind power plants more efficiently (Verdecchia et al., 2023). For example, AI can be used to predict weather patterns and adjust renewable energy production accordingly, thereby reducing waste and improving energy supply stability. However, legal responsibility for AI implementation in this sector remains unclear in Indonesia. Are energy companies required to adhere to specific standards in the use of AI to ensure sustainability? How should they be held accountable if the AI used leads to negative environmental impacts, such as excessive use of fossil fuels to support AI operations?

From an ethical perspective, the implementation of Green AI also requires greater attention. AI developed and used for sustainability purposes must adhere to clear ethical principles, particularly in terms of transparency and accountability (Leal Filho et al., 2022). AI developers must be able to explain how their technology is designed to reduce environmental impacts and how the data used in AI processes is efficiently and responsibly managed. Moreover, AI must be developed with consideration for its long-term impact on society and the environment, ensuring that the resulting technology provides benefits to all stakeholders without causing unforeseen harm.

Indonesia can learn from other countries that have made strides in developing Green AI. Countries such as Germany and Sweden, for example, have integrated technology policies with their national sustainability strategies. They have enacted regulations that encourage Green AI innovation while providing incentives for technology companies contributing to global sustainability efforts. Indonesia, with its abundant natural resources and commitment to international agreements, should also be able to adopt similar policies that promote the development of Green AI while protecting the environment.

Environmental Protection through Green AI Policy

The protection of the environment through Green AI policies in Indonesia is a crucial step in balancing technological advancement with ecological sustainability. Green AI, or artificial intelligence designed to minimize negative environmental impacts, has the potential to address many current ecological challenges, such as climate change, pollution, and natural resource management. However, for Green AI to effectively contribute to environmental protection, clear and measurable policies and legal frameworks are essential (Zhang et al., 2024). An evaluation of the current policies in Indonesia reveals that regulations directly supporting the development of Green AI are still very limited. Therefore, it is important to identify the gaps in the existing legal framework and formulate more proactive policies.

Indonesia's legal framework related to technology and environmental protection is largely governed by Law No. 32 of 2009 on Environmental Protection and Management (UUPLH) and Presidential Regulation No. 22 of 2017 on the National Energy Plan (RUEN). However, these regulations do not specifically accommodate the development of environmentally friendly AI technologies. UUPLH regulates environmental protection in a broader context, primarily in terms of natural resource management and pollution control. Article 3 of UUPLH emphasizes that the goal of environmental management is to achieve sustainable development that is environmentally sound.

Nevertheless, these provisions do not directly address AI technology in relation to energy efficiency and carbon emission reduction, which are central to the concept of Green AI.

One of the main challenges in developing Green AI policies in Indonesia is the lack of regulations specifically governing the use of AI-based technologies for environmental protection. Green AI can be utilized to increase efficiency in various sectors, such as renewable energy, agriculture, waste management, and transportation. However, without a supportive legal framework, its implementation will not be optimal. For instance, RUEN prioritizes the use of renewable energy as one of Indonesia's main targets to achieve a greener energy mix. However, RUEN does not provide guidelines or rules on how technologies such as AI can be used to optimize renewable energy usage, indicating a regulatory gap that needs to be addressed by new policies.

In a more specific legal framework for Green AI, several key points must be included in new policies to ensure that this technology truly contributes to environmental sustainability. First, regulations must establish operational standards for companies that use AI, including Green AI, to ensure that the technologies they employ adhere to sustainability principles. These standards should include requirements for using energy-efficient AI, minimizing environmental impacts, and contributing to carbon emission reductions.

Second, policies must mandate environmental audits and certifications for any company utilizing AI. These certifications could be based on existing international standards, such as those developed by the International Organization for Standardization (ISO) or the European Green Deal (Xue et al., 2022). This is important to ensure that the technology used truly meets "environmentally friendly" claims and does not cause greater negative impacts. Additionally, regular audits should be conducted to ensure ongoing compliance with the existing regulations.

Third, the new legal framework should also include incentives for companies that adopt Green AI in their operations. These incentives could take the form of tax reductions, subsidies for green technology research and development, and easier access to green financing. With such incentives, companies would be more motivated to innovate in developing environmentally friendly technologies, including AI, which can help reduce energy consumption and improve the efficiency of production processes.

Furthermore, there should be provisions regarding legal and ethical responsibility for developers and users of Green AI. AI developers should be held accountable for the impact of the technologies they create, both environmentally and socially. For instance, if AI used in the energy sector is inefficient and leads to increased carbon emissions, the responsible company should be held accountable for the environmental damage caused. This regulation should also include ethical principles in the development of Green AI, such as transparency in data usage and accountability for the outcomes produced by the technology.

Indonesia must refer to international law developments related to environmental sustainability and green technology. The Paris Agreement of 2015, for example, commits nations to reduce carbon emissions and keep global temperature rises below 2 degrees Celsius. Green AI can play an important role in achieving this target, particularly in managing renewable energy and industrial efficiency. National policies must align with these international commitments, enabling Indonesia to actively contribute to global efforts to combat climate change.

Indonesia can also learn from the European Union's Green Digital Strategy, which provides guidelines on how digital technologies, including AI, can be used to support sustainability goals. The EU has established a legal framework that encourages companies to adopt green technologies and implement strict environmental policies. This experience can serve as a reference for Indonesia in developing Green AI policies that not only focus on environmental protection but also create a technological ecosystem that fosters green innovation.

CONCLUSION

Green AI has great potential to support Indonesia's sustainable technology ecosystem by improving energy efficiency, reducing carbon emissions, and assisting in the transformation of the industry towards a greener direction. Despite the benefits, the development of Green AI in Indonesia still faces significant legal challenges as there are no regulations specifically governing its implementation. While laws such as UUPLHH and RUEN provide a foundation for environmental and energy management, they are not specific enough to accommodate AI technology as a sustainability tool.

To support the development of Green AI, Indonesia needs a clear policy framework that includes operational standards, green certification, and incentives for companies that adopt environmentally friendly technologies. These regulations should also establish legal and ethical responsibilities for AI developers and users, ensuring these technologies support ecological sustainability and not just economic gain. The right policies can make Green AI a key part of national efforts to achieve sustainability and climate change mitigation goals.

Concrete steps that can be taken include the development of operational standards for Green AI in critical sectors, such as energy and industry, and the implementation of green certification for technologies that are proven to be environmentally friendly. The government needs to strengthen the research and development sector by providing incentives for companies investing in Green AI and speeding up the licensing process. Cooperation between the public and private sectors as well as international organizations is also important to ensure effective implementation that meets sustainability goals.

CONFLICT OF INTEREST

The authors declares that there is no conflict of interest.

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