



# Public Policy, Green Technology, and Blue Innovation in the Global Circular Economy

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## Abstract

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This study explores the critical role of public policy in advancing green technology and blue innovation within the framework of the global circular economy. Using a library research method, it reviews academic literature published last five years to capture recent theoretical and empirical developments. The findings highlight that public policy provides essential regulatory frameworks, fiscal incentives, and support for research and development, which significantly accelerate the adoption of environmentally friendly practices. Green technology contributes by improving energy efficiency, reducing carbon emissions, and extending product life cycles, thereby aligning industrial activities with sustainability objectives. Blue innovation, on the other hand, emphasizes the sustainable utilization of marine resources, including ocean energy, sustainable fisheries, and marine biotechnology, offering solutions to global challenges such as plastic pollution and overexploitation of marine ecosystems. The study concludes that the integration of public policy, green technology, and blue innovation is fundamental to achieving an inclusive and resilient circular economy that supports sustainable development and global environmental preservation.



## **1. Introduction**

Global climate change, environmental degradation, and overexploitation of natural resources have become central issues in the sustainable development of the 21st century. International agendas such as the Sustainable Development Goals (SDGs), the Paris Agreement, and the European Green Deal affirm the importance of transitioning to a more environmentally friendly and sustainable development model. Indonesia, as one of the countries with a large wealth of natural resources, also faces significant challenges in managing economic development without sacrificing environmental sustainability. Therefore, the implementation of the circular economy, which emphasizes the principles of reduce, reuse, recycle, and regenerate, is an important framework in formulating long-term sustainability strategies.<sup>1</sup>

Linear economies based on a “take-make-dispose” pattern have proven to be no longer relevant to today's global challenges. The energy crisis, deteriorating environmental quality, and increasing industrial waste indicate the need for an alternative economic model that is more adaptive and efficient. In this context, the circular economy is seen as able to overcome resource limitations while reducing the carbon footprint. The application of this concept cannot be separated from the support of green technology and blue innovation. Green technology includes the use of renewable energy, low-emission transportation, energy efficiency, and waste management, while blue innovation focuses on the sustainable use of marine

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<sup>1</sup> Dorota Simpson. "The Concept of Green, Blue and Circular Economy." *book Per mare ad astra. Space technology, governance and law* 2 (2021).

resources, such as ocean wave energy, marine biotechnology, and sustainable fisheries.<sup>2</sup>

Public policy plays a strategic role in encouraging the adoption of green technologies and blue innovation as the foundation towards a circular economy. The right policies not only create a conducive investment climate, but also direct Research and Development (R&D), establish carbon emission regulations, and accelerate the diffusion of environmentally friendly technologies to the industrial sector. Recent studies show that public policy interventions contribute significantly to increasing the implementation of green technology and marine resource-based innovations in various development sectors.<sup>3</sup> This confirms that the success of the transition to a circular economy is determined not only by technological factors, but also by visionary and sustainability-oriented policy designs.

In the Indonesian context, the challenges of implementing a circular economy include limited infrastructure, low adoption of environmentally friendly technology, and weak coordination between institutions in policy formulation. However, there is a great opportunity to integrate green technology and blue innovation through progressive regulations. This effort is important, considering that Indonesia has great potential in the marine and renewable energy sectors that can be the main

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<sup>2</sup> Lisa A. Pace, Ozcan Saritas, and Alan Deidun. "Exploring future research and innovation directions for a sustainable blue economy." *Marine Policy* 148 (2023): 105433.

<sup>3</sup> Bonaraja Purba, Novita Sari Br Kaban, Rahel PL Hutahaean, Teofilus Rahmat Zandroto, and Imam Nur Dirham. "Konsep Ekonomi Sirkular Model Circular Bisnis Circular dan Ekonomi Karbon Sirkular." *Economic Reviews Journal* 3, no. 3 (2024): 2029-2034.

driving force for sustainable development.<sup>4</sup> With a strong policy base, Indonesia can position itself as one of the pioneers in the implementation of a technology-based circular economy in the Southeast Asian region.

A number of previous studies have highlighted the contribution of green technology in improving energy efficiency and reducing carbon emissions, as well as the role of blue innovation in preserving marine ecosystems. However, the literature that integrates all three aspects of public policy, green technology, and blue innovation in the circular economy framework is still relatively limited. Most studies tend to examine these aspects separately. Therefore, this study is here to bridge the literature gap by examining the relationship between the three in strengthening the implementation of the circular economy in Indonesia.

Thus, the main objectives of this study are: (1) to explore the role of public policy in accelerating the adoption of green technologies and blue innovations; (2) analyze the contribution of green technology and blue innovation to the implementation of the circular economy; and (3) provide strategic policy recommendations based on empirical findings. It is hoped that the results of this research can enrich the academic literature as well as provide practical input for policy makers in facing global and national sustainability challenges. As an effort towards a sustainable future, the integration of public policies, green technology, and

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<sup>4</sup> Sónia Barroso, Filipa R. Pinto, Agostinho Silva, Frederica Gil Silva, Ana M. Duarte, and Maria M. Gil. "The Circular Economy Solution To Ocean Sustainability: Innovative Approaches For The Blue Economy." In *Research Anthology on Ecosystem Conservation and Preserving Biodiversity*, IGI Global Scientific Publishing, (2022): 875-901.

blue innovation is a key pillar in building a circular economy that is inclusive, resilient, and adaptive to global dynamics.<sup>5</sup>

## 2. Literature Review

A review of the literature on the circular economy, green technology, and blue innovation shows significant conceptual and empirical developments in the last decade. The circular economy is seen as an alternative development model that emphasizes resource use efficiency, waste reduction, and ecosystem regeneration. This principle differs fundamentally from traditional linear models that are dominated by consumption and disposal. In the context of sustainable development, the implementation of the circular economy has been proven to provide benefits not only in terms of the environment, but also in terms of economic growth and the creation of new jobs.<sup>6</sup>

In addition, green technology has a strategic position in strengthening the implementation of the circular economy. The use of renewable energy, innovations in transportation systems, and technology-based waste management have become important instruments in reducing carbon emissions and improving energy efficiency. In Malaysia, for example, the implementation of a circular economy integrated with green technology has been proven to support the sustainable

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<sup>5</sup> Jennifer Elston, Hugo Pinto, and Carla Nogueira. "Tides of change for a sustainable blue economy: a systematic literature review of innovation in maritime activities." *Sustainability* 16, no. 24 (2024): 11141.

<sup>6</sup> Thiago AC de Melo, Marcelo A. de Oliveira, Sara RG de Sousa, Raimundo K. Vieira, and Thayane S. Amaral. "Circular economy public policies: A systematic literature review." *Procedia Computer Science* 204 (2022): 652-662.

development agenda while improving the quality of the environment.<sup>7</sup> This shows that the success of the circular economy requires technological innovation that continues to develop and is integrated with local and global needs.

Furthermore, the concept of blue innovation is also getting more and more attention in the academic literature. This innovation includes the sustainable use of marine resources through marine energy, sustainable fisheries, and marine biotechnology. Recent systematic studies emphasize that blue innovation is not only important in preserving marine ecosystems, but also plays a role in driving the circular economy agenda in the maritime sector. These innovations are a bridge between ecological sustainability and economic growth through the responsible use of marine potential.<sup>8</sup> The existing literature underlines the importance of integrating public policy, green technology, and blue innovation as key pillars towards effective circular economy implementation. However, research that examines the interconnectedness of the three in an integrated manner is still limited, so it is a gap that needs to be filled by further studies.

### **3. Method**

This study uses a library research method with a descriptive qualitative approach. This method was chosen because it is suitable for analyzing the linkages between public policy, green technology, and blue innovation in supporting the

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<sup>7</sup> Eglantina Hysa, Alba Kruja, Naqeeb Ur Rehman, and Rafael Laurenti. "Circular economy innovation and environmental sustainability impact on economic growth: An integrated model for sustainable development." *Sustainability* 12, no. 12 (2020): 4831.

<sup>8</sup> Jennifer Elston, Hugo Pinto, and Carla Nogueira. "Tides of change for a sustainable blue economy: a systematic literature review of innovation in maritime activities." *Sustainability* 16, no. 24 (2024): 11141.

implementation of the circular economy. Through literature studies, researchers can comprehensively review the results of previous research, scientific articles, policy reports, and relevant official documents. The focus of the research is directed to academic publications published between the last five years, thus allowing for an up-to-date overview of the conceptual and empirical developments of the issue under review.

The main data source in this study comes from scientific articles published in internationally and nationally reputable journals. The articles are obtained through databases such as Google Scholar and other open publication platforms. The selection of articles is carried out by considering keywords such as green technology, blue innovation, public policy, and circular economy. From the search results, only articles that meet the criteria of relevance, novelty, and academic quality are selected for further analysis. This process aims to ensure that the data used in the research has high validity and reliability.

Data analysis is carried out through a content analysis approach, which is by identifying the main themes that emerge from the literature reviewed. The analysis stage begins by categorizing the literature based on the focus of the discussion, for example related to green technology, blue innovation, public policy, or the integration of the three. Furthermore, each article is studied to find a common thread that connects those concepts in the context of sustainable development and the circular economy. In this way, researchers can construct solid arguments regarding the role of public policy in driving the adoption of green technologies and blue innovations.

To maintain objectivity, this study also applies source triangulation. That is, the information obtained from one article is compared with the findings of another article to ensure consistency and avoid interpretation bias. In addition, the data is also verified by comparing academic literature with public policy documents and international reports, so that the results of the analysis are not only theoretical but also relevant to implementation practices in the field.

With this approach, the research is expected to be able to make a significant contribution to the development of academic literature related to the integration of public policy, green technology, and blue innovation in building a circular economy. In addition, the method of literature study allows for the exploration of a broader perspective, as it covers a wide range of different geographical contexts and industry sectors. The results of the analysis will then be presented in the research findings section to show how the three aspects can synergize in driving the transition to sustainable development.

## **4. Results**

### **4.1. The Role of Public Policy in the Circular Economy**

Public policy plays a fundamental role in directing the transition to a circular economy. Policy instruments such as environmental regulations, fiscal incentives, emission standards, and support for Research and Development (R&D) have been proven to have a significant impact on accelerating the adoption of sustainable practices. Research shows that without a strong policy framework, the

implementation of green technology and blue innovation will be slow due to weak incentives for the private sector and society.<sup>9</sup>

One of the tangible forms of public policy role is the regulation of carbon emission reduction. Countries with strict emission targets, such as the European Union with the European Green Deal, have succeeded in creating an investment climate that encourages the development of green technologies. This policy not only provides a clear direction for the business world, but also creates a new market for environmentally friendly products. On the other hand, countries that do not have strict regulations tend to lag behind in innovation due to the lack of structural pressure or economic incentives. This is in line with the view that public policy is not only an administrative instrument, but also a driver of socio-economic transformation towards sustainability.<sup>10</sup>

In the Indonesian context, efforts towards a circular economy still face significant challenges. One of them is the weak coordination between government agencies in drafting consistent regulations. In addition, incentive support for the industrial sector oriented towards green technology is still limited. However, Indonesia's great potential in the renewable energy and marine sectors opens up opportunities for the integration of public policy with technological innovation. If

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<sup>9</sup> Bonaraja Purba, Novita Sari Br Kaban, Rahel PL Hutahaean, Teofilus Rahmat Zandroto, and Imam Nur Dirham. "Konsep Ekonomi Sirkular Model Circular Bisnis Circular dan Ekonomi Karbon Sirkular." *Economic Reviews Journal* 3, no. 3 (2024): 2029-2034.

<sup>10</sup> Safran Effendi Pasaribu. "Analisis Transformasi Administrasi Publik Melalui Tinjauan Literatur: Pendekatan Sosiologi Pembangunan dan Organisasi." *Dinamika Reformasi Administrasi Publik Tantangan dan Peluang di Era Global* (2024): 109.

policies are directed consistently, Indonesia can become one of the centers for circular economy development in Southeast Asia<sup>11</sup>.

Public policy also plays a role in shaping public awareness about the importance of sustainable consumption and production patterns. Through public education, environmental awareness campaigns, and strengthening educational curricula that emphasize sustainability, the government can encourage long-term behavioral change. This behavior change is crucial because the circular economy requires not only technological innovation, but also community participation in adopting an environmentally friendly lifestyle. Therefore, the synergy between regulations, incentives, and public education is the main pillar in strengthening the role of public policy in encouraging the circular economy.

#### **4.2. Contribution of Green Technology to the Circular Economy**

Green technology encompasses a wide range of innovations that focus on reducing environmental impact through energy efficiency, the use of renewable energy, and better waste management. The contribution of green technologies to the circular economy is evident in the ability of these technologies to extend the life cycle of products, reduce dependence on fossil fuels, and minimize waste production. Through the application of renewable energies such as solar, wind, and

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<sup>11</sup> Normalisa Md Isa, Arunnaa Sivapathy, and Nur Nadia Adjrina Kamarruddin. "Malaysia on the way to sustainable development: Circular economy and green technologies." In *Modeling economic growth in contemporary Malaysia*, Emerald Publishing Limited, (2021): 91-115.

biomass, green technology contributes directly to the achievement of the SDGs' goals, particularly in terms of clean energy and action on climate change.<sup>12</sup>

Studies in various countries show that the application of green technology can significantly reduce carbon emissions. For example, the development of low-emission transportation such as electric vehicles can reduce air pollution in urban areas while improving people's quality of life. In addition, technology-based waste management allows for the reprocessing of materials thereby reducing dependence on limited natural resources. This is in line with the main principles of the circular economy that emphasizes reuse and recycle as resource management strategies.<sup>13</sup>

In Southeast Asia, the application of green technology is starting to show a positive impact on sustainable development. Malaysia, for example, through the integration of green technology in circular economy practices, has succeeded in improving energy efficiency in the industrial sector and reducing the volume of solid waste produced.<sup>14</sup> This success is proof that green technology has great potential to support the transition to a more sustainable economic model.

However, challenges in the implementation of green technologies are still considerable, especially related to the high initial investment costs and limited technical capacity in developing countries. Therefore, public policy support is key in

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<sup>12</sup> Dorota Simpson. "The Concept of Green, Blue and Circular Economy." *book Per mare ad astra. Space technology, governance and law 2* (2021).

<sup>13</sup> Sónia Barroso, Filipa R. Pinto, Agostinho Silva, Frederica Gil Silva, Ana M. Duarte, and Maria M. Gil. "The Circular Economy Solution To Ocean Sustainability: Innovative Approaches For The Blue Economy." In *Research Anthology on Ecosystem Conservation and Preserving Biodiversity*, IGI Global Scientific Publishing, (2022): 875-901.

<sup>14</sup> Eglantina Hysa, Alba Kruja, Naqeeb Ur Rehman, and Rafael Laurenti. "Circular economy innovation and environmental sustainability impact on economic growth: An integrated model for sustainable development." *Sustainability* 12, no. 12 (2020): 4831.

creating an environment conducive to the adoption of this technology. Through the provision of tax incentives, green financing schemes, and support for research and innovation, these barriers can be reduced so that green technology is more accessible to the industrial sector and society. Thus, it can be concluded that green technology is not only ecologically relevant, but also strategic in strengthening the circular economy in various development contexts.

### **4.3. The Significance of Blue Innovation in Supporting the Circular Economy**

Blue innovation refers to the sustainable use of marine resources with the aim of maintaining ecosystem balance while encouraging economic growth. Its scope includes sustainable fisheries, marine energy, marine biotechnology, and marine waste management. In the framework of the circular economy, blue innovation plays an important role in strengthening the management of marine resources so that waste can be minimized and the added value of marine ecosystems can be optimized.<sup>15</sup>

The latest study confirms that blue innovation is one of the main strategies in dealing with global ocean crises, such as plastic pollution and declining fish stocks. Blue economy-based projects implemented in various countries have shown success in reducing marine waste through recovery and recycling approaches. For example, a project in Italy shows that the management of marine plastics can have a direct impact on public policy by encouraging new regulations related to marine waste

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<sup>15</sup> Shuhong Wang, Weiyao Li, and Lu Xing. "A review on marine economics and management: How to exploit the ocean well." *Water* 14, no. 17 (2022): 2626.

management.<sup>16</sup> These findings show that blue innovation not only provides ecological benefits, but also influences policy frameworks at the national and international levels.

In addition, blue innovations contribute to food security through sustainable fisheries practices. By adopting new technologies, the fisheries sector can increase productivity while maintaining the sustainability of fish stocks. Marine biotechnology also opens up new opportunities in the pharmaceutical and food sectors through the sustainable use of marine organisms. This contribution shows that blue innovation has enormous economic potential when managed with a circular approach.<sup>17</sup>

In a global context, the Blue Economy 2030 agenda encourages the integration of blue innovation with the circular economy framework to ensure the long-term sustainability of marine ecosystems. This approach emphasizes the importance of cross-sectoral and cross-disciplinary collaboration in developing a comprehensive strategy. Thus, blue innovation is not only seen as a conservation effort, but also as an economic development strategy that is able to create a balance between human needs and the preservation of the marine environment.<sup>18</sup>

The results of this study show that synergy between public policy, green technology, and blue innovation is key in strengthening the implementation of the

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<sup>16</sup> Lorenzo Vassallo, Andrea Appolloni, Chiara Fantauzzi, and Rocco Frondizi. "Reducing Plastic Pollution by Recovery and Recycling: Evidence from a "Blue Economy" Project Impacting Policy-Making in Italy." *International Journal of Environmental Research and Public Health* 20, no. 8 (2023): 5604.

<sup>17</sup> Jennifer Elston, Hugo Pinto, and Carla Nogueira. "Tides of change for a sustainable blue economy: a systematic literature review of innovation in maritime activities." *Sustainability* 16, no. 24 (2024): 11141.

<sup>18</sup> Le Thanh Ha. "Achieving a blue economy through the circular initiatives: a path towards sustainable marine living resources." *Environmental Science and Pollution Research* 31, no. 9 (2024): 13656-13672.

circular economy. Public policies provide direction and incentives, green technologies provide technical solutions to reduce environmental impacts, while blue innovations ensure the sustainability of marine ecosystems which are one of the key resources for global development. The integration of these three can be a strong foundation for the transition to a more inclusive, sustainable, and resilient economy to the challenges of climate change and environmental degradation.

## **5. Discussion**

The results of the study show that the integration between public policy, green technology, and blue innovation is a determining factor for success in the implementation of the circular economy. The three complement each other: public policy serves as a normative foundation and incentive, green technology serves as a technical instrument to reduce environmental impact, while blue innovation ensures the sustainability of the use of marine resources. However, the implementation of these three aspects is inseparable from a number of challenges that need to be criticized.

First, in terms of public policy, there is a gap between the formulation of regulations and the implementation in the field. Although many countries have adopted policies related to the circular economy and sustainability, their implementation is often hampered by budget constraints, weak coordination between institutions, and resistance from industry players. This is in line with the findings that although regulatory frameworks have evolved, the effectiveness of public policies is largely determined by the consistency of implementation and

stakeholder participation.<sup>19</sup> Without synergy between sectors, public policy has the potential to become only a normative document without having a real impact on economic transformation.

Second, green technology has a very important role but faces cost and accessibility challenges. In developing countries, the adoption of green technologies is often constrained by high initial investment costs and limited technical capacity. This makes it difficult for small and medium-scale industrial sectors to implement the technology. However, case studies in Malaysia show that the integration of green technology in the circular economy can be successful if supported by progressive regulations and adequate incentives.<sup>20</sup> Therefore, academic discourse emphasizes the importance of the role of government in lowering structural barriers through green financing, subsidies, and technical capacity building programs.

Third, blue innovation offers great opportunities in supporting the sustainability of marine ecosystems, but at the same time faces global challenges such as plastic pollution and overexploitation. Research shows that blue innovation-based projects can be concrete solutions, for example through marine waste management and marine energy development. However, this success is highly dependent on a policy framework that is able to integrate ecological and economic aspects. As emphasized by Pace et al.<sup>21</sup> blue economy development requires cross-sectoral and

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<sup>19</sup> Thiago AC de Melo, Marcelo A. de Oliveira, Sara RG de Sousa, Raimundo K. Vieira, and Thayane S. Amaral. "Circular economy public policies: A systematic literature review." *Procedia Computer Science* 204 (2022): 652-662.

<sup>20</sup> Normalisa Md Isa, Arunnaa Sivapathy, and Nur Nadia Adjrina Kamarruddin. "Malaysia on the way to sustainable development: Circular economy and green technologies." In *Modeling economic growth in contemporary Malaysia*, Emerald Publishing Limited, (2021): 91-115.

<sup>21</sup> Lisa A. Pace, Ozcan Saritas, and Alan Deidun. "Exploring future research and innovation directions for a sustainable blue economy." *Marine Policy* 148 (2023): 105433.

disciplinary collaboration to create sustainable impact. Thus, blue innovation cannot stand alone, but must be part of national and international development strategies that emphasize the circular economy.

Based on the results of the analysis, it is clear that the circular economy is not just an environmental concept, but a multidimensional development framework. The integration of public policy, green technology, and blue innovation is the main requirement for the circular economy to provide optimal benefits. However, the challenges that arise suggest that an adaptive, collaborative, and evidence-based approach is needed in policy formulation. In this way, the transition to a circular economy is not only a vision, but can be implemented in real terms in various development contexts.

## **6. Conclusion**

This research confirms that the integration between public policy, green technology, and blue innovation is an important foundation in building a sustainable circular economy. Public policy has a strategic role in creating directions, incentives, and regulations that support the acceleration of the adoption of environmentally friendly technology. Without consistent and progressive policy support, the implementation of the circular economy tends to be slow and partial. Green technology has proven to make a real contribution through improved energy efficiency, better waste management, and reduced carbon emissions. Its application not only supports environmental sustainability, but also encourages economic growth through industrial innovation.

On the other hand, blue innovation expands the scope of the circular economy by harnessing the potential of the ocean in a sustainable manner. This is important for archipelagic countries such as Indonesia which have abundant marine resources. This research highlights that the success of the circular economy is highly dependent on the interconnectedness of these three aspects. Public policy contributions, green technology support, and strengthening blue innovation must go hand in hand to create a resilient, inclusive, and environmentally friendly economic system. With an integrative approach, the circular economy is not only an ideal concept, but can be realized as a real sustainable development model for the future.

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