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Green Monetary Policies and the Function of Central Banks in Facilitating the Transition to a Low-Carbon Economy: Comparative Analysis of Successful Case Studies

Benmalek Sara[1], Brahmia Nabil [2], Azzi Ferial Manel [3], Tebaibia Salima [4]

[1] Doctor, Department of economics sciences, University of Abbes Laghrour Khenchela, Algeria
Benmalek.sara@unv-khenchela.dz

[2] Doctor, Department of commercials sciences, University of 8 May 1945, Guelma, Algeria salima.
brahmia.nabil@univ-guelma.dz

[3] Doctor, Department of finance ang accounting sciences, University of Constantine 2-Abdelhamid Mehri, Algeria ferialmanel.azzi@yahoo.com

[4] Professor, Department of commercial sciences, University of 8 May 1945, Guelma, Algeria
salima.tebaibia@univ-guelma.dz

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Abstract:

This study aimed to examine the expanding role of monetary policy in facilitating the transition to a low-carbon economy, in light of escalating climate concerns and their effects on financial and economic stability. Central banks are necessitated to adjust to climate change by implementing "green monetary policy," which employs monetary and regulatory instruments to foster sustainable financing and alleviate carbon-related risks. The study analyzed the principal mechanisms employed by central banks, including the alteration of collateral regulations, implementation of climate stress tests, creation of green credit facilities, incorporation of climate risks into banking supervision, and promotion of financial innovation via green bonds and sustainable financial instruments. The chosen central banks are those that have exhibited effective experiences and models in this context, including the European Central Bank, the Bank of England, and the People's Bank of China. The latter has attained considerable development in green finance relative to the European and British models, which have advanced in incorporating climate risks into their monetary and regulatory policies, emphasizing supervision and transparency, respectively. Nonetheless, it encounters a substantial challenge referred to as "environmental shading risks". The study examined the challenges associated with implementing green monetary policy, including inadequate climate risk assessment models, insufficient data, conflicting objectives between price stability and environmental protection, and legal limitations that may restrict central banks from extending their conventional roles. The study concluded that incorporating climate issues into monetary policy is

essential for ensuring long-term stability in the pursuit of the Sustainable Development Goals (SDGs) (2030-2050), especially Goal 13 concerning climate change. It underscored the necessity for enhanced collaboration among monetary and fiscal authorities and the financial industry to expedite the transition to a low-carbon and more sustainable economy.

Keywords: Eco-friendly monetary policy, central banks, low-carbon economy, climate risk, sustainable finance.

Introduction:

Climate issues have emerged as a pivotal element in global economic discourse during the past decade, influencing not just the environmental domain but also financial stability, economic development, and market dynamics. A novel trend termed green monetary policy has evolved, embraced by central banks to facilitate the transition to a low-carbon economy while simultaneously addressing climate risks that may jeopardize financial institutions. Numerous central banks, especially in Europe and Asia, have started the integration of climate considerations into their instruments, whether by reallocating loans, endorsing green finance, or embedding sustainability requirements into refinancing operations. This trend, despite its novelty, has emerged as a strategic emphasis in contemporary monetary theory, particularly in countries aiming to improve their investment appeal and maintain financial stability. Consequently, green investments are pivotal to the success of the energy transition. The development and implementation of clean technologies are crucial to guarantee that the transition away from fossil fuels does not result in a decrease in long-term economic development (Fornaro, Guerrieri, & Reichlin, 2025, p. 8).

Numerous studies have highlighted significant concerns in research pertaining to Good Manufacturing Practices (GMP), underscoring that GMP is an essential need in contemporary contexts. Examples encompass China's initiative to restrict green bond yields, the influence of GMP on corporate bonds within European countries, and its contribution to lowering carbon emissions. Thus, the transition to green management has emerged as a new requisite standard in financial management and a mechanism for reconciling economic development aims with environmental conservation, particularly as developed countries advance towards low-carbon economies.

Thus, examining the influence of the green transition on monetary policy is crucial for assessing its contribution to sustainable development objectives in advanced economies and for offering guidance to other countries (Chi, Anh & Thu, 2025, p. 550). Additionally, climate change and the political impetus for immediate policy action have ignited significant discourse regarding the necessity for central banks to alter their monetary policy frameworks to facilitate the transition towards a more sustainable economy (Rosa, 2025, p. 1).

The objective and purpose of climate bonds is to generate capital to facilitate initiatives aimed at addressing climate change induced by global warming, which endangers humanity. The United Nations states that to meet the Paris Agreement objective of limiting the temperature increase to below 1.5°C,

global greenhouse gas emissions must be decreased by 40% by 2030, ultimately achieving net zero by 2050. Realizing these objectives necessitates sustained research and technological advancement, logistical assistance, and the worldwide proliferation of climate change mitigation strategies, including low-carbon energy technology and associated infrastructure. Consequently, sufficient financial assistance is necessary for these initiatives (CBI, 2023, p. 3).

This study provides novel and diverse additions to the current literature on green monetary policy and low-carbon economic transitions, specifically concerning Europe, Asia, and America, emphasizing the European Central Bank, the Bank of England, and the People's Bank of China. It examines the regional implications of green credit policies enacted by central banks on mitigating climate change and reducing carbon emissions. This differs from prior research that investigated how green monetary policies enacted by central banks aid in facilitating the transition to a low-carbon economy, advancing green finance, and alleviating climate risks that may jeopardize financial stability. This research paper examines the core principles of green monetary policy, outlining its development and its contribution to financial stability. It employs a comparative methodology to examine effective global practices of central banks in the execution of green monetary policy instruments. The study employs a documentary analysis of reports from international institutions, including the International Monetary Fund, the Bank for International Settlements, and the Network for Greening the Financial System (NGFS), alongside a review of recent literature published from 2021 to 2024.

The importance of this study resides in its emphasis on a recent global trend in central banking policies; monetary institutions are currently endeavoring to incorporate environmental factors into their regulatory frameworks and conventional instruments. The significance of the subject arises from its direct connection to attaining financial stability in the face of climate challenges, and the lack of comprehensive Arabic research on this matter. This renders the study a significant asset for both scholars and policymakers. Hence, it aims to examine the function of green monetary policies enacted by central banks and assess their influence on the transition towards a low-carbon economy. The study elucidates the connection between green monetary policies and the stability of the financial system, subsequently providing recommendations and strategies for policymakers to enhance the efficacy of green monetary policies in fostering a sustainable economy. Finally, the findings enhance the knowledge of the spatial and institutional dynamics of sustainable financing, offering substantial empirical and methodological contributions to the literature on sustainable green finance, clean energy, and climate change.

1. Theoretical Framework of the Research:

1.1 Climate Change and its Effects on the Economy and Financial System

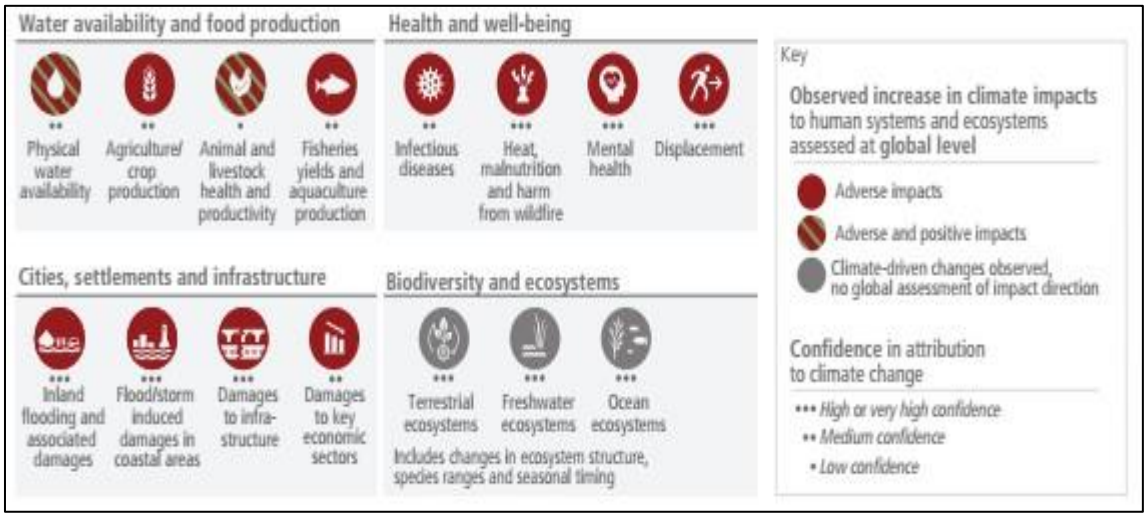
In recent decades, climate change has emerged as a significant worldwide concern, driven by accelerated alterations in weather patterns, rising temperatures, and the heightened occurrence of extreme weather events, including droughts, floods, and storms. These alterations impact the environment and exert considerable strain on national economies and global financial systems.

1.1.1 Climate Change

Climate change denotes enduring alterations in global and local temperatures and meteorological patterns caused by human activities, including greenhouse gas emissions from industry, transportation, and agriculture. These alterations encompass physical risks, like floods, droughts, storms, and sea-level rise, which directly affect productivity and infrastructure, as well as transition risks linked to the transition to a low-carbon economy. Transition risks encompass alterations in environmental regulations, carbon pricing mechanisms, and technical innovations, which may impact the profitability of high-carbon corporations and industries (Menon, Holthausen, & Breeden, 2022, pp. 7-10).

Climate change has already resulted in extensive consequences and losses concerning human systems, altering terrestrial, freshwater, and marine ecosystems globally. The observed effects are associated with physical climate changes, including numerous impacts resulting from human activity such as factors influencing climate.

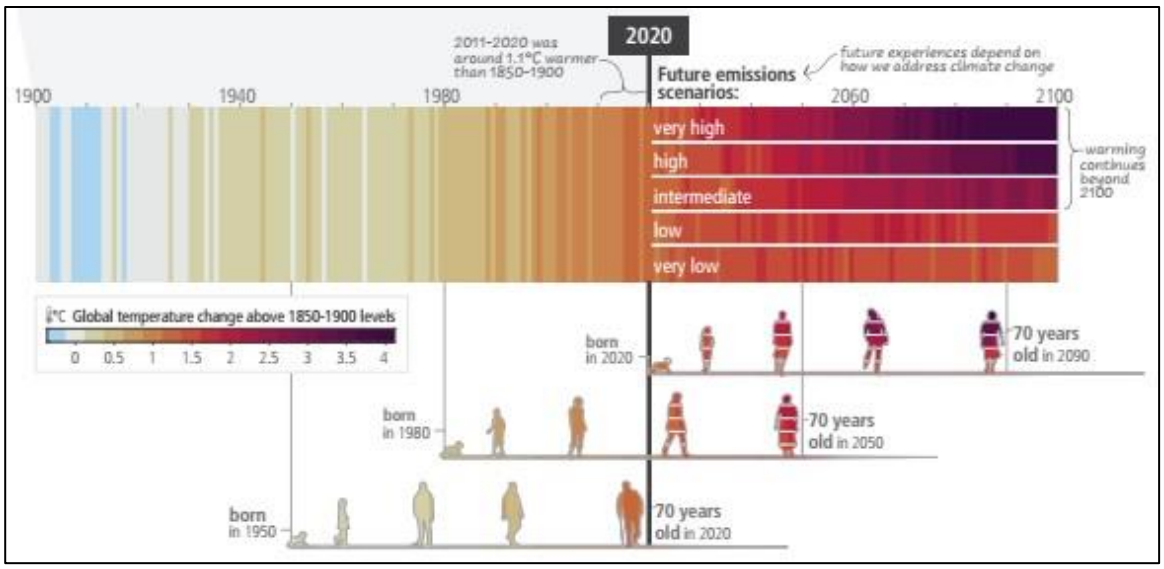
Figure 1: Consequences Arising from Alterations in Physical Climatic Conditions



Source: (Lee & Romero, 2023, p. 7)

The known alterations in Earth's surface temperature from 1900 to 2020, along with the expected changes from 2021 to 2100, are distinctly apparent when compared to the period from 1850 to 1900, and are associated with alterations in climatic conditions and their impacts (Figure 2). This demonstrates the climate change that has occurred and that is anticipated over the lifespans of three preceding generations (1950, 1980, 2020).

Figure 2: Implications of climate change for present and future generations



Source: (Lee & Romero, 2023, p. 7)

The figure above depicts the critical future forecasts for global surface temperature alterations from 2021 to 2100, emphasizing greenhouse gas emission levels: very low (1.9-SSP1), low (2.6-SSP1), medium (4.5-SSP2), high (7.0-SSP3), and very high (8.5-SSP5), denoted as "climate lines." These future estimates indicate enduring trends stemming from human activity and continuous alterations owing to natural variations.

1.1.2 Economic Consequences of Climate Change

A succession of significant transitions (digital, demographic, geopolitical, and environmental) influencing production, consumption, and technological patterns directly affects economic performance and development capability sustainably. These transitions need that countries and institutions adjust to an increasingly dynamic environment. Therefore, comprehending the effects of these developments on the economy is essential for formulating strategies that improve competitiveness and facilitate development. The aforementioned transitions can be encapsulated as follows:

- **Diminished Productivity and Economic Development:** Natural disasters and extreme weather phenomena impair agricultural, industrial, and other productivity, resulting in decreased economic development. Climate change jeopardizes corporate earnings globally through the destruction of manufacturing and supply networks, as well as the disruption of infrastructure and transportation systems. Droughts result in increased water prices, which will probably influence the expenses of raw materials and industry. Climate variability may compel corporations to manage uncertainty regarding the costs of production resources, energy transportation, and insurance. Certain products may become obsolete or lose commercial viability, such as equipment used in coal mining or skiing in regions devoid of snow (Cho, 2019).
- **Escalated Operating Expenses:** Due to the necessity of adjusting to climate change or rectifying damage inflicted by natural disasters, operational costs increase for both corporations and countries. The

cumulative cost of climate risk exposure for the S&P Global 1200 is anticipated to attain $25 trillion by 2050 under the medium-term socioeconomic climate scenario designated as 4.5-SSP2. This encompasses $4.5 trillion in lost revenue from company interruptions, $3.8 trillion in additional operational expenses, and $16.5 trillion in property damage and surplus capital expenditures (S&P Global, 2025).

- **Transforming Economic Framework:** Certain sectors, like traditional energy and carbon-intensive industries, may incur substantial losses, whereas the renewable and green energy sectors will experience development. This was vividly evidenced by China's accomplishment in 2023, wherein roughly 85% of its new power generation capacity originated from renewable energy sources. This signifies a declining role for fossil fuels amid the rapid energy transition (IRENA, 2024, p. 44).

1.1.3 Effects of Climate Change on the Financial System

The global financial system encounters escalating issues due to climate change. Climate risks have become a crucial element influencing the stability of financial institutions, the quality of assets, and the movement of investments. The increase in extreme weather occurrences has prompted economies to reduce carbon emissions, so exposing banks, insurance companies, and financial markets to physical and transition risks that jeopardize their capacity to effectively assess risks and offer sustainable financing. Thus, it is imperative to comprehend the effects of climate change on the financial system. These encompass:

- **Heightened banking and financial risks:** The exposure of banks to assets potentially impacted by climate change, such as oil companies or flood-affected real estate, elevates the probability of substantial losses, which could lead to considerable financial detriment if not adequately managed. (Yaseen, Ud Din, Shaheen, & Khan, 2024, pp. 1223-1224)
- **Financial market variations:** Reports of climatic disasters or the introduction of new carbon regulations may induce variations in stock and bond assessments (NGFS, 2024, p. 26). Uncertainty in climate policy influences the resilience of financial markets, resulting in variations in the market and in investment attitude, affecting the ratios of non-performing loans at banks (Wei, Jiang, & Zhou, 2025, pp. 22-29).
- **Escalated demand for green finance:** Beyond facing climate risks, financial markets and institutions can significantly aid the green transition by promoting investments in clean energy initiatives and sustainable infrastructure—specifically, by enabling climate-conscious investments. This offers a prospect for sustainable economic advancement. The financial sector's function in alleviating climate concerns involves financial innovations like green bonds and the portfolio allocation strategies of major institutional investors, who are progressively influenced by environmental, social, and governance (ESG) sustainability objectives. This is further substantiated by alterations in bank credit distribution reflecting banks' inclination towards green assets rather than carbon-intensive ones (Breckenfelder, et al., 2023, p. 24)
- **Constraints on monetary policy:** Monetary policy will face limitations in addressing the sectoral impacts of climate change. Hence, central banks must include climate risks in monetary policy decisions,

including liquidity management and interest rates, to safeguard financial stability. (European Central Bank, 2020, p. 19)

1.2 Concept and Objectives of Eco-Friendly Monetary Policy

The notion of green monetary policy is rather recent in the fields of sustainable economics and finance study. It emphasizes the function of central banks in advancing environmental goals using both conventional and unconventional monetary policy instruments. Numerous central banks have not yet integrated sustainability into their regulatory frameworks; yet, climate change and its related dangers (both physical and transitional) provide a direct threat to monetary and financial stability. This requires the incorporation of these factors into fundamental monetary policy frameworks (Dikau & Volz, 2021, p. 4).

Conversely, due to the absence of a singular, all-encompassing definition of green monetary policy, multiple associated notions exist. Given that this research emphasizes the significance of green monetary policy in mitigating carbon emissions, the notion of climate finance presents a more comprehensible and direct approach. It is a sector of green finance that offers financial assistance for methods aimed at mitigating and adapting to climate change. The United Nations Framework Convention on Climate Change characterizes it as the distribution of financial resources from various sources to assist in mitigating and adapting to climate change. The objective is to facilitate the economy's transition to a green economy by aligning financial flows with greenhouse gas emission reduction trajectories and fostering climate-resilient development (Hu & Gan, 2025, p. 14). In their study, Kaifeng and Chuanzhe assert that carbon finance constitutes a subset of environmental finance, encompassing various financial instruments and initiatives designed to mitigate and diminish greenhouse gas emissions through carbon emission rights, trading and investment in carbon derivatives, as well as financing low-carbon initiatives (Kaifeng & Chuanzhe, 2011, p. 1066).

Green monetary policy seeks to accomplish the following objectives:

- **Integrating climate risks into fundamental frameworks**, such as asset assessment, collateral management, and banking supervision procedures, to ensure the stability of the financial system. (Dikau & Volz, 2021, p. 5)
- **Advancing Green Finance:** Financial institutions advocate for the funding of low-carbon or sustainable initiatives via specialized mechanisms or incentives (Dikau & Volz, 2021, p. 6). This crucial significance is apparent in the transition from a fossil fuel economy, and the techniques that may be implemented are diverse. This encompasses interaction with corporations via their shareholders, promoting divestment from fossil fuels, and refusing finance or credit to fossil fuel corporations attempting to initiate new initiatives. A clear plan is to allocate capital to more environmentally sustainable sectors, while certain challenges must be addressed in this context. Central banks have emerged as significant purchasers of assets to fulfill their objective of fostering economic stability. Evidence indicates that the European Central Bank's portfolio, for example, disproportionately favors carbon-intensive sectors. Higher-emission sectors typically issue a greater volume of bonds compared to more ecologically sustainable sectors, resulting in an imbalance. It is essential to augment the availability

of green bonds, with central banks significantly influencing this supply by rendering green bonds appropriate for their operations (Kilfoyle, 2021).

- **Advancing the Sustainable Development Goals** by facilitating financial liquidity for eco-friendly initiatives in support of national and international climate objectives. In this context, banks ought to assess the environmental sustainability of the activities they finance and use this as a motivation to redirect a portion of their lending towards low-carbon sectors (Campiglio, 2013, p. 2)
- **Enhancing Macro-Financial Stability**: Climate change might induce long-term shocks, whether via physical or transmission risks; hence, incorporating these factors into monetary policy serves as a preventive strategy to safeguard stability (Dikau & Volz, 2021, p. 7).

1.3 Eco-Friendly Monetary Policy Instruments

Although conventional monetary policy primarily aims to regulate inflation and foster economic development, central banks may also employ monetary policy instruments to advance sustainability. This can be accomplished by incorporating climate risks into economic models and predictions, comprehending them, and subsequently mitigating the impacts of environmental change on the economy. The instruments can be classified into three primary categories as follows (Faruq & Huq, 2024, pp. 6-10):

1.3.1 Direct Instruments:

Sustainable investing is the incorporation of environmental, social, and governance (ESG) factors to attain long-term financial returns alongside beneficial social and environmental outcomes. This is accomplished by exemplifying commendable practices in their investment portfolios to motivate other financial institutions to emulate, such as investing in renewable energy initiatives and other sustainable assets. Central banks can advance green finance through many mechanisms, including open market operations, lending facilities, reserve requirements, prioritization of green bond acquisitions, or provision of preferential lending rates to banks financing sustainable initiatives. By including sustainability criteria in these operations, central banks may advance green finance and facilitate the transition to a sustainable economy. The European Central Bank (ECB) exemplifies the successful integration of sustainability into monetary policy through the acquisition of green bonds under its asset purchase programs.

1.3.2 Regulatory and Supervisory Instruments:

Central banks, as regulators of financial systems, are crucial in incorporating sustainability into their policies to maintain the stability and integrity of the financial system. Central banks promote the adoption of sustainable practices by financial institutions, mandating banks to assess and disclose climate-related risks, integrate these risks into banking supervision, and develop criteria and controls for sustainable lending. They perform climate stress tests to assess the financial system's resilience to various climatic scenarios. The Bank of England (BoE) exemplifies this by incorporating climate risk into its regulatory framework, mandating that banks and insurers assess and disclose their exposure to climate risks, therefore pioneering climate risk assessments. The Bank of England has performed climate stress tests utilizing the dual climate exploration scenario, CBE, to assess the effects of climate change and

investigate associated financial risks. The outcomes of these assessments help illuminate the weaknesses of the financial system.

1.3.3 Prompting Instruments:

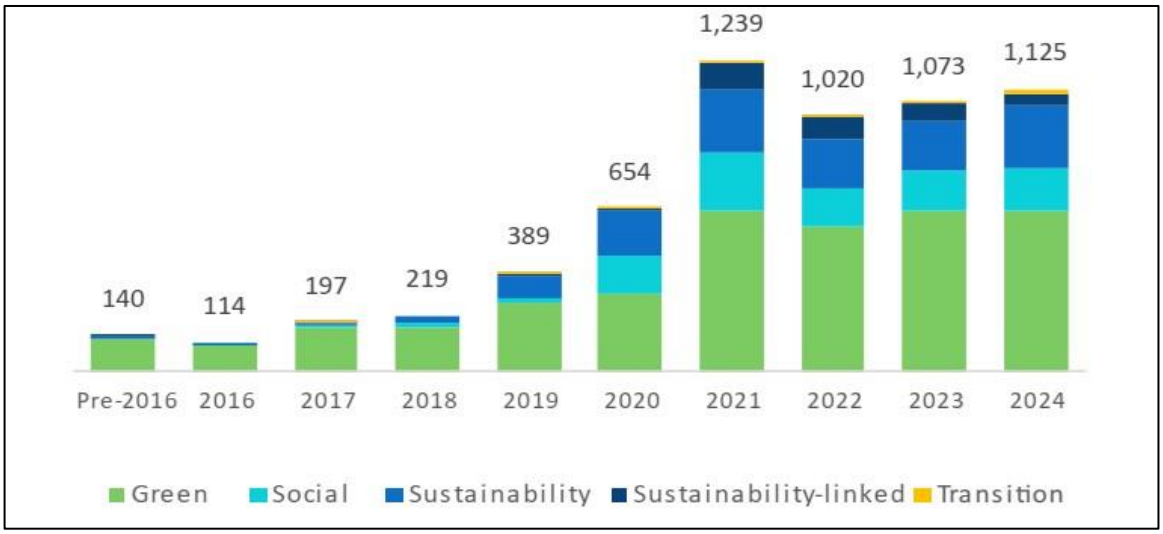
Central banks are employing a diverse strategy to include sustainability in their fundamental policies, thereby promoting a sustainable financial system. Consequently, central banks endorse innovative financial instruments and solutions that fund ecologically sustainable corporations. Among the most significant vehicles expressly created to finance environmentally beneficial initiatives are "green bonds," which serve as a crucial mechanism for mobilizing resources for sustainable development. Central banks bolster green bond markets through acquisitions, establishing issuance rules, and promoting investment by financial institutions. Prominent instances of central banks that have fostered green bond markets are the European Central Bank (ECB) and the People's Bank of China (PBOC).

2. Applied Framework of the Research:

2.1 Global Advancement of Sustainable Bond Markets

In 2024, annual issuances attained elevated levels, signifying ongoing expansion in the sustainable bond market across all categories. The entire annual issuances amounted to US$1.1 trillion By December 2024, the cumulative value of green, social, sustainability, and transition bonds (designated as sustainability bonds) issued in the market amounted to US$6.2 trillion. Nonetheless, green bond issuances persisted in leading the rated sustainable bond market in 2024, with over 57% of yearly issuances by year-end. This constitutes the most significant contribution from green bonds, establishing a record that exceeds the total amount of green bonds since the market's start in 2006.

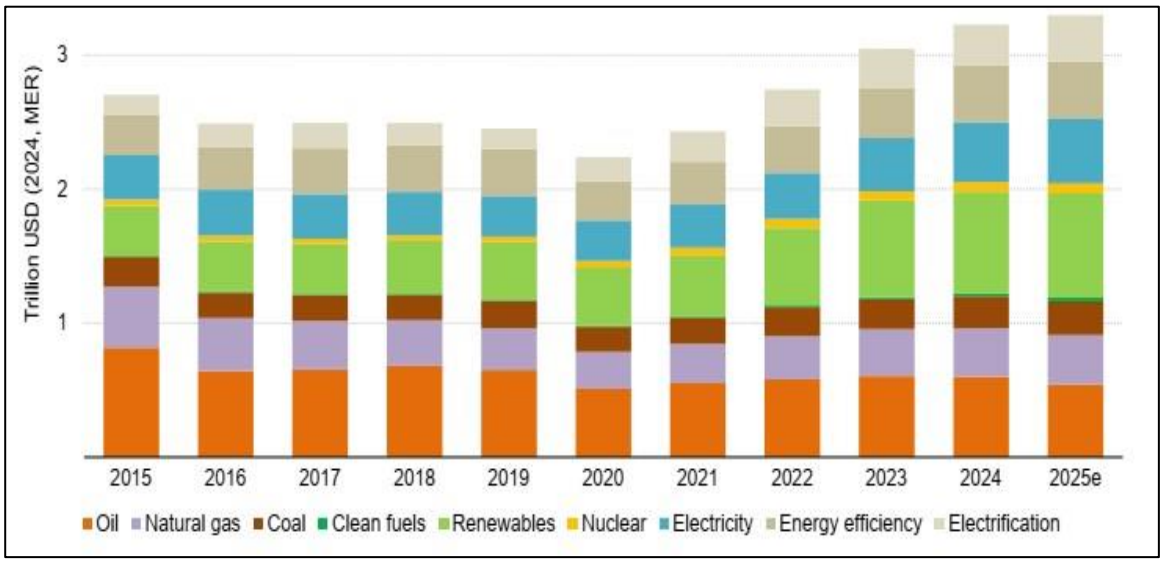
Figure 3: Annual Issuances of Globally Rated Sustainable Bonds (in US$ Billion)



Source: (WORLD BANK, 2025, p. 1)

The substantial increase in GSSS bond issuance in recent years is ascribed to the necessity of financing economic transitions towards more efficient and secure energy frameworks, alongside the rising demand for sustainable investments, which have constituted a considerable segment of this asset class expansion. The transition to energy investment has also intensified. The International Energy Agency (IEA) reports that renewable energy investments in developing countries have surged over 60% since 2018, accounting for over half of global energy investments since 2020. In 2024, clean energy investments in developing countries attained a record US$1 trillion, significantly surpassing investments in fossil fuels. The response to climate change and the use of sustainable technology have further stimulated GSSS bond issuance in emerging markets. Furthermore, regulatory reforms and enhanced standard harmonization between established and emerging markets have been helpful in augmenting transparency for both issuers and investors (IFC, 2025, p. 16). Notwithstanding rising geopolitical tensions and economic instability, capital investments in the energy sector increased to US$3.3 trillion in 2025, reflecting a 2% rise in real terms relative to 2024 (Figure 4). Approximately US$2.2 trillion was designated for renewable energy, nuclear power, power grids, energy storage, low-emission fuels, energy efficiency, and electricity—exceeding the US$1.1 trillion allotted to oil, natural gas, and coal by more than twice.

Figure 4: Global Investments in Clean Energy and Fossil Fuels (2015–2025)

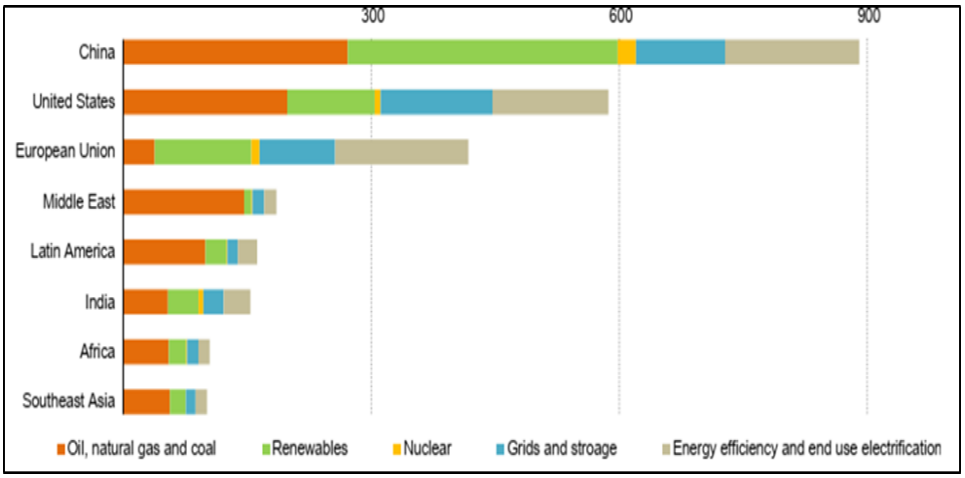


Source: (IEA, 2025, p. 12)

The energy sector has experienced a significant transition because of the swift increase in energy investments over the past five years since the recovery from the COVID-19 epidemic. 70% of the augmented expenditure originated from fossil fuel importers, propelled by China's initiatives to diminish its dependence on oil and gas imports and its preeminence in emerging technologies. This also prompted Europe to expedite investments in renewable energy sources and efficiency improvements following

Russia's comprehensive invasion of Ukraine and the resultant decrease in pipeline gas supply, alongside a significant increase in solar energy expenditures in India. The other 20% of the rise originated from the United States, whose supportive policies were driven by a desire to contest China's dominance in burgeoning clean technology supply chains, particularly in light of China's ascendance as the world's foremost energy investor (Figure 5). A notable transition in investment towards low-carbon energy generation is occurring, owing to its capacity for emissions reduction; yet, it frequently does not serve as the principal motivator for investment in increasingly advanced and economically viable technologies.

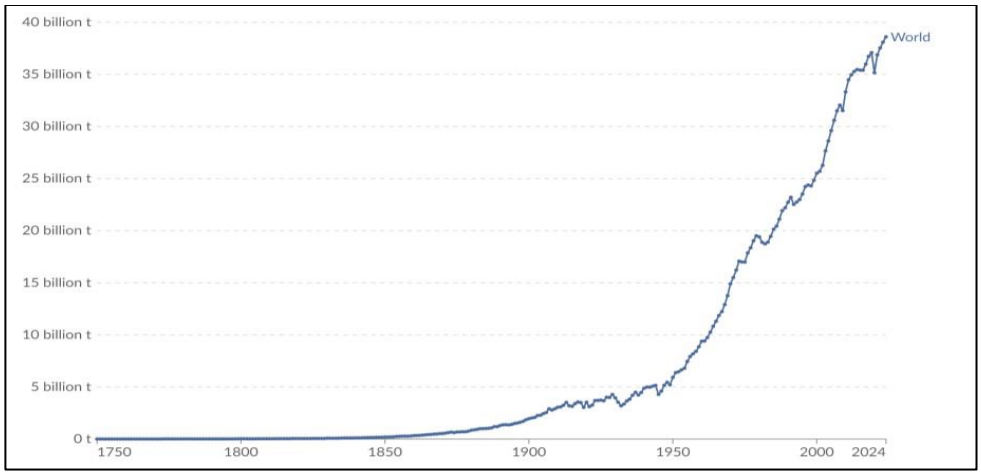
Figure 5: Distribution of energy investments by geographic region in 2025



Source: (IEA, 2025, p. 13)

Moreover, certain developing countries have acquired essential finance for the transition, especially those requiring the establishment of renewable energy infrastructure or the advancement of research and development in this domain. Nonetheless, there exists a considerable gap in funding. For instance, notwithstanding its significant need, Africa obtained less financial support than Asia or South America. Certain countries, like India and several South American states, obtained significant investment beyond $1 billion. Other countries obtained moderate financial support, varying from $10 million to $100 million (OWD, 2023). The transition to clean energy sectors is propelled by the increase in global emissions since the mid-18th century. Emissions were minimal before the Industrial Revolution and continued to be gradual until the mid-20th century (Figure 6). In 1950, global emissions attained 6 billion tonnes of carbon dioxide. By 1990, this figure had doubled to over 20 billion tonnes and continued to increase significantly, now surpassing 35 billion tonnes annually.

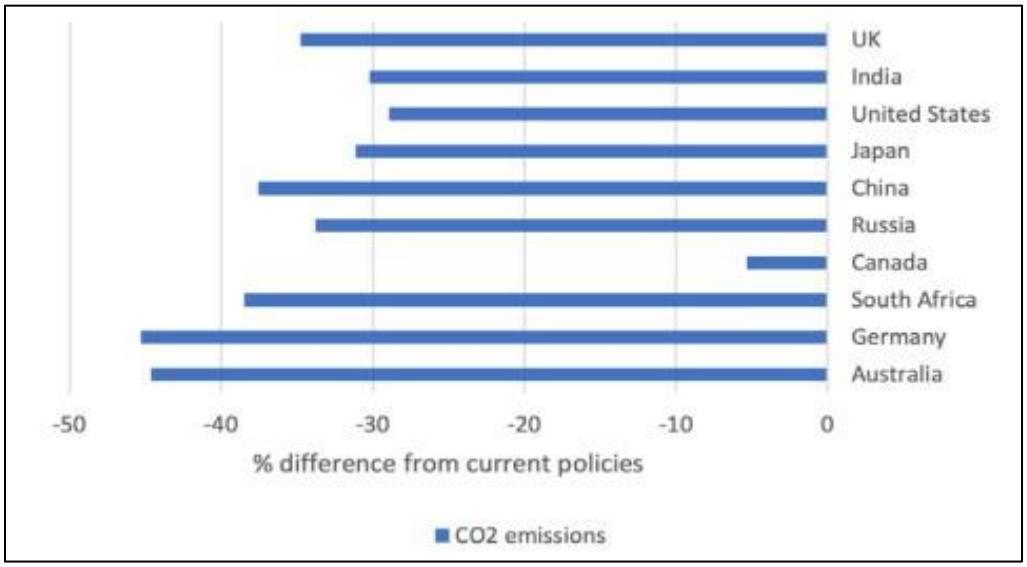
Figure 6: Annual carbon dioxide emissions from fossil fuels and industry (Unit: million/tonne)



Source: (Ritchie, 2022)

The anticipated effects on CO_2 emissions compared to baseline current policy scenarios (Figure 7) illustrate variations among countries in total energy consumption decrease and existing energy mix.

Figure 7: Decrease in fossil fuel utilization on CO_2 emissions in 2025



Source: (UNEP FI & NIESR, 2022, p. 36)

The figure above depicts the requisite percentage reduction in carbon (CO_2) emissions relative to the output of countries provided they maintain their existing policies. Each country necessitates a substantial further reduction, potentially attaining 45%, as exemplified by Australia, Germany, and South Africa, but others, like Canada, require less than 10%, indicating a smaller gap. Germany requires an extra decrease of 40–45% to meet its official target for 2030. This signifies that existing policies are ineffective and necessitate substantial enhancement or structural alterations in energy sources (transition to renewable energy), along with alterations in industry, transportation, buildings, and other sectors. This

applies similarly to other countries that have established medium-term objectives, like Canada, Japan, and Australia. Consequently, countries ought to adopt robust measures, including the transition to renewable energy, enhancement of energy efficiency, implementation of carbon taxes or emissions trading systems, and alteration of transportation and industrial practices. This is particularly crucial for large, polluting, or economically developed countries due to their substantial contribution to global emissions.

2.2 Successful Global Case Studies of Central Banks in Executing Green Monetary Policy

Amid escalating environmental concerns and the consequences of climate change, it is imperative to implement fiscal and monetary policies that facilitate the transition to sustainable economies. In this context, green monetary policies have become essential in steering economies towards a sustainable future. Numerous governments worldwide have effectively adopted green monetary policies, facilitating the transition to low-carbon economies. This results from the incorporation of environmental goals into monetary policy instruments, prompting these countries' financial sectors to embrace ecologically sustainable practices and promote innovation in renewable energy and sustainable infrastructure. The experiences of these countries in executing green monetary policies differ, using various strategies and instruments (Table 1). In this context, successful case studies will be analyzed, including the European Central Bank, the Bank of England, and the People's Bank of China, which have adeptly incorporated green policies into their monetary frameworks.

Table 1: Comparison of the most prominent pioneering experiences in implementing green monetary policy

Bank	Adopted instruments and policies	Achieved results	Learned lessons
The European Central Bank (ECB)	- **Purchasing green assets**: Integrating sustainable bonds into the central bank's portfolio to promote green finance (DOBKOWITZ, HÜTTL, KRIWOLUZKY, & WITTICH, 2023, p. 14) - **Green refinancing facilities**: Providing loans to commercial banks targeted towards environmental initiatives (ECB, 2020, pp. 12-14)	- Increased funding for environmentally friendly initiatives. - A decrease in climate risk for the European Central Bank's overall corporate portfolio between 2018 and 2022, from 238 to 166 tonnes of CO_2 equivalent to 23 million euros. - Increased financial awareness of climate risks. (DOBKOWITZ, HÜTTL) (KRIWOLUZKY, & WITTICH, 2023, pp. 18-19)	- The need to incorporate climate criteria into reserve asset investments and reinvestment. - Amending the safeguards framework to include climate risk considerations. - Climate disclosure and participation in international networks for sharing expertise and criteria. (ECB, Climate Risk and Stress Test, 2022, pp. 20-22)

	- **Climate stress tests**: Measuring banks' exposure to potential climate risks (ECB, Climate Risk Stress Test, 2022, pp. 5-10)		
Bank of England BOA	- **Implementing climate stress tests** to assess banks' exposure to future climate risks. - **Other supporting measures**, such as redirecting loans from carbon-intensive sectors to financing less carbon-intensive sectors. - **Integrating climate risk into banking supervision** (Bank of England, 2022).	- Enhancing banks' ability to predict climate shocks and reduce systemic risks. - Improving banking transparency regarding climate risks.	- The importance of continuously updating regulatory frameworks. - The necessity of integrating climate testing with regulatory strategies.
People's Bank of China (PBOC)	- **Green bonds** as eligible collateral assets or sustainability bonds for project financing (Macaire & Naef Green, 2022, p. 3). - **Regulatory guidelines and incentive policies** for the banking sector (CBI, 2023, pp. 19-20). - **Green loans:** dedicated to renewable energy initiatives, clean transportation, pollution prevention, and water management (Haijao, 2024, pp. 32-47). - **Green financial instruments and derivatives for**	- Green loan portfolio development, reaching 30 trillion yuan by the end of 2023, a 36.5% increase from 2022 (Zhang, Song & Nedopil, 2023-2024, p. 13). - Increasing green bond issuance by other banks and institutions. - Improvements in financing instruments at the Bank of China, such as allocating returns and expanding green products (green leases, green insurance, green funds, carbon finance, transition finance).	- Contributing to improved market transparency and credibility. - Focusing on transition, not just on green initiatives, which may lead to what is known as "environmental shading" (Zhao, 2022, pp. 1097-1098). - Coordination between legislators, banks, and financial institutions.

	transition financing: to reduce emissions with phased implementation. - **Partnerships and external solutions:** to attract international capital and enable large initiatives through their subsidiaries.	- Conflicting results and tangible effects between increased flows towards green initiatives and the lack of evidence of carbon emission reductions.	

Source: Prepared by Researchers

The table above clearly indicates a substantial disparity among the three central banks in the execution of green policy. The European Central Bank (ECB) concentrated on incorporating sustainability into its monetary and supervisory policies, as demonstrated by its rigorous assessment of climate risks. The Bank of England (BOE) focused on financial supervision and the incorporation of climate risks into its regulatory framework, emphasizing transparency and the mitigation of systemic risks. The People's Bank of China (PBOC) concentrated extensively on direct financial prompting for the banking sector and green initiatives, employing advanced instruments to secure global finance. Nonetheless, regarding the outcomes attained, the ECB's performance is notable, exhibiting concrete positive indicators in the bank's portfolio and the financial system's cognizance of climate risks, in contrast to the BOE, whose inferior results in direct financing, although significant for fostering financial stability and effective supervision, signify its success. This means that the ECB's strategy of incorporating sustainability into all facets of monetary and supervisory policy is producing concrete outcomes, and that the BOE's advanced and thorough supervision of climate risks also enhances financial stability. Nonetheless, the beneficial outcomes of the PBOC are equally significant. From a financial standpoint, the PBOC has not verified the actual environmental damage, suggesting the potential of "environmental shading." This emphasizes that significant financing for green initiatives is inadequate; it must be accompanied by tangible environmental performance metrics. Therefore, the following conclusions can be drawn:

- The European Central Bank (ECB) employs a sophisticated model for incorporating climate risks into its monetary and regulatory policies, resulting in a measurable effect on the bank's portfolio.
- The Bank of England (BOE): a model that emphasizes supervision and transparency, improving banks' capacity for forecasting and adaptation; yet, its direct influence on green finance is minimal.
- The People's Bank of China (PBOC) has significantly increased green finance but encounters the issue of verifying the actual environmental impact, specifically the possibility of environmental shading.

2.3 Challenges to the Implementation of Green Monetary Policies

Given the intensifying climate change and rising environmental challenges, the significance of green monetary policies in attaining economic and environmental sustainability has increased. The

execution of these policies encounters a series of intricate problems that may impact its efficacy in promoting the transition to a low-carbon emission economy. They are as follows:

- **Insufficient climate risk data:** Adequate detailed information is lacking for the analysis of climate-related risks. Limited availability of precise data about emissions, physical risks, and transmission risks impedes the execution of climatic stress tests (Vermeulen, Schets, Lohuis, Kölb, Jansen, & Heeringa, 2018, reliable, pp. 11-12).
- **Legal and regulatory frameworks:** This issue is particularly pronounced as certain central banks do not possess a clear legal mandate to employ monetary policy instruments in support of environmental goals. This may generate conflict between their conventional responsibility for monetary stability and their role in promoting climate sustainability (Tamez, Weenink, & Yoshinaga, 2024, pp. 3-6).
- **Distortion of market neutrality:** Should central banks prioritize "green" assets, it may engender unanticipated financial risks (Tamez, Weenink, & Yoshinaga, 2024, pp. 16-17).
- **Developing Models for Assessing Climate Risks:** Climate risks are inherently long-term, whereas the majority of monetary policy models focus on the near term, so complicating forecasting and planning. Hence, it is essential to create models that provide a proactive assessment of climate risks and their macroeconomic and societal impacts. Assessing these effects is challenging due to the potential time trade-offs involved, as well as the possibility of unpleasant or unforeseen repercussions. This necessitates the integration of dynamic macroeconomic modeling within the context of Integrated Assessment Models (IAMs), Agent-Based Models (ABMs), Dynamic Stochastic General Equilibrium (DSGE) models, Stable Fiscal Equilibrium (SFE) models, climatic scenarios, historical analysis, and political economy factors. Central banks can facilitate these initiatives by engaging with modeling communities (Campiglio, 2018, p. 10).
- **Political and economic resistance:** Central banks may encounter substantial difficulties, especially if their autonomy is undermined by the broadening of their duties to encompass climate goals. This may be perceived as an encroachment against environmental policymaking, which ostensibly falls under the purview of governments (Fornaro, Guerrieri, & Reichlin, 2024).

Based on the above, the efficacy of these instruments is significantly contingent upon the caliber of governance, transparency, and congruence with fiscal and environmental policies. So in formulating green monetary policy instruments or strategies, central banks must assess the architecture of their domestic financial systems and the ability of their markets to react to these green incentives.

2.4 Prospects and Consequences of Enacting Green Monetary Policies

Green monetary policy signifies a strategic advancement towards establishing a sustainable economy by incorporating environmental factors into monetary policy frameworks, hence creating new economic prospects. Nonetheless, these prospects entail intricate economic ramifications that must be addressed to guarantee equitable environmental and economic results.

2.4.1 Prospects of Enacting Green Monetary Policies:

Numerous countries are endeavoring to attain sustainable development and confront environmental issues. Green monetary policy uses monetary instruments (including interest rates, open market operations, and reserve requirements) to advance environmental goals. This can be succinctly summarized as follows:

- **Advocating for Sustainable Finance Instruments:** Green monetary policies incentivize banks to finance low-carbon initiatives, including renewable energy and clean mobility. An exemplary instance is "green loan" initiatives, which facilitate environmental investments and augment the demand for sustainable financial products. (Office of Development Initiatives, 2021, p. 9)
- **Promoting Financial Innovation:** Green monetary policies facilitate the creation of novel financial instruments, like green bonds, environmental portfolios, and sustainable investment funds. These would augment market diversity and generate opportunities for banks and investors. (Smaoui, 2025, pp. 4-5)
- **Enhancing the Role of Central Banks**: The involvement of central banks in facilitating the transition to a low-carbon economy bolsters their credibility and positions them as proactive agents of sustainable development. (ODI, 2021, pp. 3-8)
- **Promoting the Green Economy:** Investments in low-carbon or clean sectors foster job creation, advance technical innovation, and specifically aid in attaining the Sustainable Development Goals. (Smaoui, 2025, pp. 4-5).

2.4.2 Potential Consequences of Green Monetary Policies:

Despite the advantages and prospects, policymakers may encounter difficulties in harmonizing monetary and environmental policies to achieve economic stability goals. In certain instances, this may result in conflicts between the necessity to foster economic development and environmental responsibilities. The primary potential consequences encompass:

- **Upholding Financial and Economic Stability:** Green monetary policies mitigate climate-related risks to the banking sector, including losses linked to markets or assets vulnerable to carbon exposure (Khai Nguyen, 2025, pp. 1-3).
- **Changing the Investment Framework:** By channeling funds into the green economy, investments progressively transition towards eco-friendly initiatives, diminishing dependence on high-emission industries, thereby positively influencing the macroeconomy (Tang, Huo, Wang, Abdalla Adam & Bai, 2025, p. 3).
- **Influence on Interest Rates and Liquidity:** The implementation of green monetary policy instruments may alter interest rates associated with green finance and selectively alter market liquidity, necessitating vigilant supervision (NGFS, 2024, p. 27).
- **Environmental and Institutional Awareness:** Advocating for green policies elevates environmental awareness within financial institutions, corporations, and investors, thereby fostering a culture of sustainability in the financial sector. (United Nations Environment Programme, 2022)

3. Conclusion:

Central banks are a crucial entity in the transition towards a low-carbon economy. They achieve this by implementing astute monetary policies that promote environmental sustainability while simultaneously fostering a sustainable economy, combatting climate change, and safeguarding the welfare of future generations.

Nonetheless, due to escalating environmental concerns and transitions, their participation in combating climate change has become increasingly vital. Climate change has emerged as a central focus of monetary policy and a crucial element in climate change mitigation, alongside its function in diminishing carbon dioxide emissions. Central banks employ various instruments, including green fiscal stimulus, interest rate alterations, support for corporations adhering to sustainable environmental practices, investment in clean sectors, green financial innovations, and the imposition of stringent conditions on loans for initiatives with detrimental environmental effects.

Based on the above, this research concluded the following:

✓ Monetary policy underscores the significance of funding green initiatives, which mitigates the risks linked to activities with enduring environmental consequences.

✓ Green finance mitigates climate change by decreasing carbon emissions and facilitating the transition to a sustainable economy, so reconciling economic development with the preservation of environmental and natural resources, thereby promoting sustainable development.

✓ Central banks advocate for financial institutions to incorporate environmental considerations into their financial decisions to foster environmentally responsible investments, by channeling lending towards clean initiatives such as renewable energy, sustainable agriculture, waste and water management, and sustainable transportation, inter alia.

✓ Central banks endeavor to advance sustainable practices by developing green financial instruments, such as green bonds, to finance and safeguard eco-friendly initiatives.

✓ Central banks and regulatory authorities formulate policies and legal frameworks that promote sustainable investment, collaborating with diverse private entities including pension funds, sovereign wealth funds, insurance companies, and financial markets focused on green, social, and sustainable securities.

✓ The rise in global green bond issuances reflects a growing interest in environmentally beneficial investments. So banks and financial institutions endeavor to furnish essential finance for environmental sustainability initiatives while simultaneously mitigating global environmental challenges.

✓ The European Central Bank's green monetary policies illustrate its capacity to foster environmental sustainability within the financial system while concurrently maintaining economic stability. Its primary problem resides in reconciling economic and environmental objectives while assuring the availability of appropriate instruments for recognizing and assessing environmental risks.

✓ The Bank of England's green monetary policies seek to promote sustainable investment, aiming to reconcile environmental sustainability with the soundness of the financial system. Nonetheless, significant challenges persist, such as accurately assessing environmental risks and maintaining the seamless integration of environmental and financial policy.

✓ The People's Bank of China has undertaken substantial initiatives for sustainability by enacting green monetary policies, leading to considerable expansion in investments for sustainable initiatives. Nonetheless, it has challenges in adeptly directing corporations towards sustainable practices.

✓ The integration of regulatory frameworks and fiscal policies, exemplified by the European Central Bank (ECB), produces a harmonious balance between efficient finance and financial stability. Extensive finance, exemplified by the People's Bank of China (PBOC), is inadequate for attaining sustainability objectives.

✓ Notwithstanding the challenges encountered by central banks in executing green finance initiatives, present endeavors by countries demonstrate a robust dedication to attaining sustainable development, positively influencing the construction of a sustainable future.

Recommendations:

The subsequent recommendations can be followed by central banks to mitigate carbon dioxide emissions via monetary policy:

✓ Climate objectives must to be officially included into central bank monetary policy, either by facilitating the funding of sustainable green infrastructure initiatives or by steering investments towards renewable energy sources. This can be accomplished by integrating environmental criteria into monetary policy decisions, such as designating a fraction of reserves. Central banks may also promote private sector investment in clean technology and sustainable practices.

✓ Central banks ought to alter prudential measures to foster sustainability, including capital criteria and monetary policy instruments. This can be executed through instruments such as green fiscal prompting or the provision of credit incentives granted to corporations that comply with environmental and social criteria.

✓ Urging financial companies to reveal their assets' vulnerability to environmental and climate change concerns. Central banks should consequently improve transparency in environmental risk assessment by enforcing elevated criteria of transparency and accountability in environmental risk reporting, including collaboration with international organizations such as the Financial Action Task Force (FATF) to establish global criteria for disclosing environmental risks in sustainability reports;

✓ Allocating essential capital for financial innovations that enhance energy efficiency and mitigate emissions, including green bonds. Central banks must assume a pivotal role in fostering research and innovation in green finance and clean technology.

✓ Central banks must engage with governments and other international organizations to synchronize environmental and economic policies, ensuring coherence between climate objectives and monetary policies. The World Bank and the International Monetary Fund (IMF) should collaborate to formulate cohesive climate policies that promote financial stability and mitigate emissions.

✓ Enhancing environmental awareness and culture within the financial sector by educating financial institutions on environmental risk management and providing guidance on the adoption of sustainability policies. This can be accomplished by conducting frequent seminars and conferences to demonstrate best practices and problems in incorporating environmental criteria into financial policies;

✓ Offering incentives and advantages for investment in sustainable industries by implementing accommodating fiscal policies, such as reduced interest rates or tax incentives for investors in environmentally sustainable initiatives. Additionally, endorsing capital markets that designate a fraction of their resources to finance sustainable initiatives;

✓ The necessity for ongoing assessment of climate policy performance and regular assessment of their efficacy to guarantee the attainment of established objectives. This entails the implementation of monitoring and assessment frameworks to assess the influence of environmental policies on the stability of the financial system, including the comparison of environmental performance across countries;

✓ Promoting the engagement of the financial sector in the attainment of the Sustainable Development Goals (SDGs), especially Goal 13 concerning climate change. This can be achieved by involving commercial banks and financial institutions in the funding of green initiatives, including renewable energy and emissions reduction initiatives.

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