





Role of green financing and energy production to mitigate climate change in emerging economy like Bangladesh

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ABSTRACT

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This study examines the role of green financing and energy production to mitigate climate change in emerging economies like Bangladesh. In today's world, climate change is a significant issue that impacts humans on an environmental, social, and economic level. However, this study aims to explain how to mitigate climate change with the support of green finance and green energy in Bangladesh. The study uses mixed methods to conduct the research, such as quantitative and qualitative methods. In this particular case, the study identified several crucial factors that contribute to the effects of climate change. Two environmentally friendly tools, like green finance and green energy, are used to fight climate change. Green finance, comprising financial instruments like green bonds and loans, finances significant investments in environmental projects, particularly renewable energy, that promote the transition to a greener, low-carbon economy and ultimately help to combat climate change. Solar, wind, hydropower, biomass, and biofuels are the common green energy production technologies in Bangladesh, which can play a pivotal role in reducing climate change by reducing greenhouse gas emissions. In Bangladesh, green finance contributes to investment in green energy projects, innovation in clean energy technologies, investment risk management, and energy transitions, according to the research. The study suggests valuable implications for the Bangladesh government, policymakers, and other policymakers taking effective initiatives to protect Bangladesh from the gulf of devastating climate change.

Contribution/Originality: This study contributes to the fields of environmental economics, green finance, and green banking to increase the contribution to existing literature and policy implications.

1. INTRODUCTION

The dynamic world is proceeding towards being economically sustainable with the help of different technologies and innovation, collaboration with each other in complex missions, international trade, and globalization. However, the world is lagging behind in terms of environmental sustainability. Most large companies and organizations focus basically on profit generation, which leads them to economic development (Islam, Rahman, Tanchangya, & Islam, 2023) without considering the environment. Therefore, environmental issues have become the primary concerns for environmentalists and policymakers in the modern era. Thus, climate change is considered one of the biggest environmental issues all over the world, and it has affected nations socially, environmentally, and economically. That's why climate change (CC) is on the main agenda of almost all the world summits, such as the Conference of the Parties (COP), the United Nations Framework Convention on Climate Change (UNFCCC), the World Economic Forum (WEF), etc. Climate change poses a global threat that progressively intensifies pressure on various sectors (Abbass et al., 2022). This threat is already evident globally, impacting both the environment and economic sectors (Borowski, 2022). It already exacerbates ecosystems, fresh water supplies, food, health, and agricultural sectors all over the world (VijayaVenkataRaman, Iniyar, & Goic, 2012). Global temperature has gradually increased due to Climate Change (CC) (Abbass et al., 2022; Battisti & Naylor, 2009; Schuurmans, 2021; Yadav et al., 2015) with projections indicating a rise of 1.0 to 1.4°C during 2046–2065 and 1.0 to 3.7°C during 2081–2100 (Mojid, 2020). According to the Inter-Governmental Panel on Climate Change (IPCC), in the last century, global sea level rose by about 17 cm (VijayaVenkataRaman et al., 2012) and it is estimated that it will be doubled compared to the last century. The main reason for CC is the greenhouse effect. Appendix Table 1A presents a list of abbreviations for GHG emissions. There are two causes for such emissions: the natural system and human activity. Natural systems include forest fires, earthquakes, oceans, permafrost, wetlands, mud volcanoes, and volcanoes (Fawzy, Osman, Doran, & Rooney, 2020; Yue & Gao, 2018) and human activities include deforestation, unwise energy consumption, rapid industrialization, etc.

According to Edenhofer et al. (2014) and Fawzy et al. (2020) half of the total world population is living in cities, and they are mostly responsible for GHG emissions (Gouldson et al., 2016; Mi et al., 2019). Industrial activities significantly accelerate climate change. (Andreopoulou, 2016; Gibon, Popescu, Hitaj, Petucco, & Benetto, 2020; Ng, Nathwani, Fu, & Zhou, 2021). Unpredictable weather patterns, continuously retreating ice sheets, and sea level increases are the most well-known local and international effects of climate change (CC) (Abbass et al., 2022; Lipczynska-Kochany, 2018; Michel, Eriksson, & Klimes, 2021; Murshed & Dao, 2022). Though developed countries are mostly responsible for climate change, underdeveloped and developing countries are greatly vulnerable to climate change. The countries that are mostly vulnerable to climate change are Nigeria, Afghanistan, South Sudan, Somalia, Chad, Bangladesh, Haiti, etc. Due to its geographical location and socioeconomic characteristics, Bangladesh is a severely vulnerable country to climate change (Wu et al., 2021). This country already started to experience high temperatures, where last year in 2023 the highest temperature was 41 °C (Bdnews 24, 2023) and the lowest temperature was 6.2 °C (The Business Standard, 2023) and the average weather was between 30°C and 40°C in the summer session, and the average temperature was between 15°C and 25°C in the winter session, but historically, Bangladesh has experienced average temperatures around 26°C, and the range was between 15°C and 34°C throughout the year. CC is already visible in almost all the sectors in Bangladesh, such as agriculture, health, food, energy, the ecosystem, tourism, etc.

In the agricultural sector, climate change already affects production and distribution, and as a result, food prices are becoming higher day by day (Tai, Martin, & Heald, 2014). The agricultural sector plays a crucial role in Bangladeshi livelihoods (Alam, 2015; Islam & Nursey-Bray, 2017). According to the Bangladesh Economic Review, the contribution of the agriculture sector to GDP was 11.20% and 45.33% of all employment in Bangladesh (The Daily Star, 2023a). However, due to high temperatures, unpredictable natural calamities are negatively affecting the agriculture sector. As a result, Bangladesh's vast population is at stake for food security (Alauddin & Sarker, 2014;

Bates, 2008). Climate change significantly hinders the blue economy, particularly by endangering marine species (Ning et al., 2023). Moreover, climate change has devastating effects on human health. Moreover, every year, more than 150,000 people die because of CC. People in Bangladesh also face health hazards, especially temperature-related illnesses, food poisoning, water pollution, and vector-borne diseases (Hasib & Chathoth, 2016). However, the study aims to mitigate climate change with the support of green finance and green energy (GE) production in Bangladesh. Green financing and green energy are two effective instruments to mitigate CC climate change. Green financing aims to increase the level of financial flows, including banks, microcredit, insurance, and public and private investment, while also supporting non-profit businesses to support sustainable development priorities.

The main purpose of green financing is to tackle environmental and social risks, provide opportunities that bring not only a decent rate of return but also environmental excellence, and ensure greater accountability (UNEP, 2024a). Collaboration of monetary and financial resources and promotion of sustainable development is a primary goal of green financing, as it aims to reduce ecological impacts while decreasing unfavorable consequences for the environment and habitats in accordance with sustainable progress (Wang, Shahid, Binh An, Shahzad, & Abdul-Samad, 2022; Zhou, Tang, & Zhang, 2020). The ultimate goal of green financing is to ensure tremendous investments and financing in eco-friendly initiatives (Berrang-Ford, Ford, & Paterson, 2011). In this case, Bangladeshi organizations are also playing a significant role in reducing environmental degradation. For example, private commercial banks are the most significant contributors to green financing in Bangladesh. Around 75% and 12% of total green financing from NBFIs comes from private commercial banks (Hossain, 2019; Khairunnessa, Vazquez-Brust, & Yakovleva, 2021; Zheng, Siddik, Masukujjaman, & Fatema, 2021), which ensure environmental protection. Major green financing projects financed by banks and other financial institutions in Bangladesh as per the guidelines of Bangladesh Bank are recycling and recyclable products, waste management, liquid waste, renewable energy, energy efficiency, alternative energy, fire-burnt brick, non-fire-brick brick, green industry, safety and security of factories, etc. GF may reduce the overall internal carbon footprint and external carbon output (Akter, Siddik, & Mondal, 2018; Hossain, 2018; Zheng, Siddik, Masukujjaman, Fatema, & Alam, 2021). Moreover, to promote the green garments industry, public and private green financing promotes garment sectors by following the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (Leed). There are 173 factories in Bangladesh that currently lead the world in the RMG industry's progress towards being green, and the government of Bangladesh plans to set up 100 green economic zones by 2030 (The Dhaka Tribune, 2023).

On the other hand, energy is the main driving force for development and urbanization, and power is more responsible for environmental degradation than other things. Policymakers argue that current energy production and supply systems are unable to sustain the demands of future generations, and as a result, the environment will be more adverse than before (Shamoon, Haleem, Bahl, Javaid, & Garg, 2022). To protect the planet from the devastating impact of climate change, policymakers now focus on renewable energy, or GE production. Natural resources produce GE, an environmentally friendly energy (Raihan, Tanchangya, Rahman, & Ridwan, 2024). The world's developed countries are rapidly increasing their GE production and use. Moreover, they are increasing their investment in GE generation and in R&D to develop new GE technologies to protect the environment. In this regard, Bangladesh has a few green technologies to produce GE, but they are comparatively low according to demands to save nature. Nevertheless, to protect the environment, the Bangladeshi government established the Sustainable and Renewable Energy Development Authority (SREDA) in 2012 to increase the practice of green energy, which includes both renewable energy and energy efficiency sectors that provide security in Bangladesh's energy sector (Hossain, 2018). According to Bangladesh's draft national solar energy action plan, the country aims to add approximately 41 GW of solar power to its electricity grids by 2041. Experts estimate that the addition of 7,500 MW of solar power, through appropriate funding mechanisms like green bonds, could boost the country's energy security (The Daily Star, 2023b).

Moreover, the European Investment Bank (EIB) and Bangladesh signed agreements worth €400 million for renewable energy projects so that Bangladesh can move from traditional energy sources to sustainable green sources and achieve the country's climate mitigation targets (EU, 2023). The Mujib Climate Prosperity Plan (MCCP) aims to achieve 30% power from renewable energy by 2030 and 40% by 2041, and Bangladesh has planned a total of 4,095 MW of renewable energy generation by October 2027, primarily showing an upward trend in the business standard (2023). There are several prior studies conducted on GF, GE production, and climate change mitigation. For example, in an empirical study conducted by Zhang, Chen, Tang, and Qiao (2022) they found that GE and GE investment can reduce CO₂ emissions. Mngumi, Shaorong, Shair, and Waqas (2022) also found the same result when using the same indicators. Nawaz et al. (2021) concluded that GF has a significant effect on CC. Khan, Riaz, Ahmed, and Saeed (2022); Mehboob, Ma, Mehboob, and Zhang (2024); Sun, Li, Dilanchiev, and Kazimova (2023), and Wu et al. (2021) found that GF plays a crucial role in reducing environmental degradation. In the BRI context, Chin, Ong, Ooi, and Puah (2024) showed that there is a negative and significant relationship between GF and environmental degradation. It means that GF plays a crucial role in reducing environmental degradation. Numan, Ma, Sadiq, Bedru, and Jiang (2023) found that green finance can help reduce the 0.28% ecological footprint and contribute to achieving a sustainable environment. According to Rahman and Majumder (2021), using GE reduces CO₂ emissions. In SAARC countries, Zeb, Salar, Awan, Zaman, and Shahbaz (2014) concluded that GE has negative and significant effects on CO₂ emissions. In the perspective of sub-Saharan African nations, Zandi and Haseeb (2019) argued that GE consumption is one of the crucial steps to reduce environmental hazards. There are a number of empirical studies that found a negative and significant relationship between GE consumption and environmental degradation (Chien et al., 2021; Qing et al., 2024; Rizwanullah, Shi, Nasrullah, & Zhou, 2024; Suki, Suki, Sharif, Afshan, & Jermsittiparsert, 2022).

After conducting a critical review of previous studies, the researchers for this study were unable to identify a single theoretically oriented investigation, despite the existence of several studies based on these three variables. Therefore, it is a demand for time to show a comprehensive study based on these indicators in the emerging economy, particularly in Bangladesh. This study offers significant contributions to various stakeholders. This investigation will help to deepen understanding for researchers, academicians, and policymakers regarding the devastating environmental, social, and economic impacts of climate change, the instruments, advantages, and mechanisms of GE, the sources of GE, and their environmental-friendly characteristics. This research can help all parties understand the mechanisms by which green finance and green energy production reduces environmental degradation and ensure a sustainable environment. This study provides insights into the existing literature by integrating these three crucial variables into a framework. This research will be an important arm for policymakers and financial institutions to recheck their existing policies, develop new regulations, and motivate innovation in green financing products and green technology to protect our beloved Bangladesh from climate change. This research is also important for those countries that are vulnerable to climate change.

2. INTERRELATION BETWEEN GF AND GE PRODUCTION

The climate crisis necessitates a domain-revision of the world economy and energy frameworks. Green loans and GE production are building the core of this change that provides the whole system with fuel to speed it up and to go down to a zero-carbon future. Green financing meets the crucial investment requirements of the new growth opportunities in clean energy. The energy sector exhibits actual green products, which can be used to mobilize the green capital provided. They are apprehending these causes thoroughly and prioritizing essential keys in designing pertinent climate change counteraction programs. Write a detailed paragraph discussing your personal experiences and their impact on your moral character.

2.1. GF: The Engine for Sustainability

GF comprises diverse financial instruments, all aimed at promoting environmental sustainability by increasing the volume of investments in projects and actions aimed at preventing GHG emissions, building resilience to climate change, and dealing with many other environmental challenges. This broad concept does not set apart one specific type of financial instrument, product, or service but rather encompasses all tools created to support the transformation of the economy towards being more environmentally friendly and sustainable (UNEP, 2024a).

Since green bonds are debt securities, they serve as tools for allocating funds exclusively to environmental projects. These scenarios mainly include projects on developing renewable energy, thus clearly showing an intention of moving most enterprises away from fossil fuels into more eco-friendly ones. In addition, green loans play a crucial role in determining the use of financial resources to finance the development and implementation of inventions that promote environmental protection and projects. One of the ways this has been realized is by creating a conducive business environment that enables the flow of capital into projects and, hence, achieving sustainability goals.

Moreover, established green investment funds also provide a vital function by attracting investors' attention toward companies and projects that generally deal with clean energy, resource-saving, and ecological development. These funds not only promote financial growth but also support the growth of the green economy as well. Green insurance and risk mitigation products enhance the financial banking for green-related assets and investments, which are used as tools to protect renewable assets and green investments. The functions of insurance make them the ideal solution for instilling financial confidence among investors, where they will increase their investment in the green sector, and hence the assertion of the whole essence of GF as a foundation for the success of sustainable practices.

2.2. GE and the Clean Power Revolution

The transition to GE encapsulates a vital change from obtaining electrons only from non-renewable sources to harnessing power from natural and renewable sources, such as solar, wind, hydrocarbons, and certain biofuels. The absence or low, negligible contribution of these renewable energies to GHGs distinguishes them as significant partners in global decarbonization strategies. The world of clean energy stands in a vibrant array of colours and variety, with multiple sectors crucial to the development and integration of renewables in our day-to-day lives.

First, clean energy generation is one of the components of this revolution, mainly comprising the operation and development of power plants that utilize renewable energy sources to make electricity. In turn, sustainable, low-emission energy generation refers to a sustainable energy future and reduces the carbon footprint significantly (IRENA, 2023a). Energy efficiency can find its place here, with certain technologies and procedures designed to ensure optimal energy use. Waste creation and demand reduction for energy promote the sustainability of energy systems.

Further, the creation and maintenance of GE infrastructure, including the transmission media and energy storage systems, are the main elements promoting the widespread and efficient utilization of renewable energy. This infrastructure is required to supply the intermittency that threatens the stability and reliability of such sources (Rahman, Ruma, Hossain, Nahrin, & Majumder, 2021). These elements, including renewable energy technology, a well-designed regulatory framework, incentives for consumers and industries, and industries focused on GE research and development, are the pillars of the GE industry that drive us to a cleaner and more sustainable energy future.

2.3. GF and GE - Fostering a Synergistic Relationship

The relationship between GF and GE production is characterized by a positive feedback loop, illustrated as: GF Mechanisms (Green bonds, loans, funds, etc.) --> Investment Capital --> GE Projects (Renewable energy

generation, energy efficiency, infrastructure) --> Reduced Emissions & Environmental Benefits --> Attractive Returns for Investors --> Increased Investor Confidence --> Growth of GF Market Let's break down the key ways in which GF and GE fuel each other's development:

i. Mobilizing Capital: GF is suitable for GE because it overcomes the enormous investment difficulties this sector faces. Renewable power projects, specifically large-scale ones, usually consume much of the early capital. Green bonds and loans are valuable channels to fill the resource allocation gaps so the construction of new solar farms, wind turbines, and hydropower plants can progress more efficiently (Sadiq, et al., 2022).

ii. Scaling Up Innovation: A rapid energy transition demands continued research, development, and deployment of innovative GE technologies. GF supports this process by channeling resources into promising research projects, pilot initiatives, and the commercialization of cutting-edge clean energy solutions.

iii. Managing Risk: Investments in renewable energy sometimes carry perceived risks, particularly in less established markets. GF instruments can assist in managing risks from the effects of climate change. Green insurances; for example, protect investments against extreme weather events, while loan guarantees reduce investor uncertainty. Inherent risk reduction is the reason for increased private sector participation and emerges as one of the critical drivers of GE deployment.

iv. Supporting Energy Transition in Developing Countries: Many developing countries face significant barriers to financing and implementing renewable energy projects. Multilateral development banks, climate funds like the Green Climate Fund, and international financial institutions provide concessional loans, grants, and technical assistance to support GE projects in these regions, accelerating their transition towards low-carbon energy systems.

3. CONCEPTS OF CLIMATE CHANGE (CC)

The history of CC began in the early 19th century, when the ice ages and other natural changes like paleoclimate were first suspected by the natural greenhouse effects. In this era, some scientists argue that human minimization could change the earth's balance and atmosphere (Cardoso, Cartwright, & Huppert, 2020). French mathematician Joseph Fourier proposed the existence of greenhouse effect in early 1824, while French physician Claude Pullets established the theory of argument in 1827 and 1838 (Godwin & Author, 2022). In 1896, a characteristic paper by Swedish researcher Svante Arrhenius predicted that changes in atmospheric CO₂ levels could substantially alter the surface temperature through the greenhouse effect. The CO₂ increases in Earth's atmosphere due to global warming. IPCC established itself in 1988 to offer a comprehensive scientific analysis and the influence of demographic consumption on climate change. Some researchers argue that greenhouse gases may be caused by early industrialization and also by human agency. In recent years, environmental change has reflected strong arctic surface heating and huge cooling over the Southern Ocean and Antarctica, which may be imposed to an environmental strength or weakness of southern hemisphere (Dudman & De Wit, 2021). The effects of climate change include sea level rise, crop yields, and impact on water availability, extreme weather effects, and coral reef loss. For this reason children and mainly pregnant women are affected by health conditions that are direct or indirect through heat, weather events, and air pollution.

3.1. Causes of CC

Natural processes and human activities have a complex relationship resulting from climate change, which manifests as a vast phenomenon and spans the spectrum of a global scale. Carbon dioxide and other GHG emissions are the fundamental contributors since they warm up the surface temperature of the earth and fuel (Ahmed, Areche, Sheikh, & Lahiani, 2022; Numan et al., 2023) Fossil fuel burning alongside various industrial processes, deforestation, and how farming is done collectively contribute to exacerbating GHG emissions (Yu, Zhou, Cheok, Kubiczek, & Iqbal, 2022). Burning of fossil fuels up the CO₂ level increases and fastens the warming process

because it spreads massive amounts of carbon dioxide, methane, and nitrous oxide into the atmosphere (Borowski, 2022; Liu, Imran, Nassani, Binsaeed, & Zaman, 2024). The issue is aggravated by deforestation simply because it not only releases carbon, which the world has deposited for years, but also reduces the number of trees available on the surface of the globe that can absorb it (Rahman, Tanchangya, Rahman, Aktar, & Majumder, 2024; Rahman, Voumik, Akter, & Radulescu, 2023). C=Industrial processes contribute significantly to the acceleration of climate change (Andreopoulou, 2016; Gibon et al., 2020; Ng et al., 2021). Besides, methane and nitrous oxide emissions are considered part of the intensive livestock and fertilizer application area. The shift in land-use patterns in this field leads to more carbon emissions and changes in carbon storage models (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Trivedi, Chakraborty, & Nobanee, 2023). Designing and making environments involves sustainable environmental stewardship and counteracts unfavourable implications caused by climate change on global ecosystems and human societies by understanding and combating these causal factors. Lessening the discharge of GHGs, offering a lot of support to sustainable land management, and putting into practice more renewable sources of energy are the most significant steps that are inevitable to mitigate the effects of climate change and create a future where present and future generations will be living in a healthier environment.

3.2. Effects of CC

Global warming due to climate change, culminating in the loss of ecosystems in different parts of the world and endangering humans, is a complex problem. Numerous studies have demonstrated an increasing pace of sea level rise in tandem with Earth's warming (Ainou, Ali, & Sadiq, 2023; Tariq et al., 2022). Scientists who are researching low-lying spaces such as Great Masurians lakes in Poland found out that as a result of these waters, the seashore is flooded, the dwellers have to be resettled, and the process of seashore erosion intensifies more and more (Kocur-Bera & Czyża, 2023). The risk of heatwaves, droughts, floods, and other extreme events is increasing in frequency and magnitude (Smith et al., 2023; Sun, Fang, Iqbal, & Bilal, 2022). Every day, the catastrophic damage these disasters cause to people, property, and economies becomes apparent, illustrating the dire need for immediate measures to counter and adapt to these changes. According to Nawaz et al. (2021) and Li (2023) changes in precipitation patterns disrupt ecosystems and agricultural systems, which worsen social vulnerabilities and affect food security. Ecosystems are already under pressure from changing weather patterns and the loss of natural habitats, and biodiversity loss is a worrying byproduct (Lin, Zeng, Zeng, Mohsin, & Raza, 2023). Marine species are endangered, and their vulnerable ocean habitats are interrupted due to the negative impacts of ocean acidification, suggest (Ning et al., 2023). Ecosystems and food security deterioration exacerbate food security issues, especially in vulnerable zones (Chen & Chen, 2021). Furthermore, excess heat leads to heat-related illnesses, vector-borne diseases, and respiratory diseases, which multiplies the adverse outcomes of CC on the health of the human population (Yaghoubi, Yazdanpanah, & Komendantova, 2019). Water scarcity, misuse of natural resources, forced migration, and resource shortages endanger societal security (Woo, 2018). The need for collective, worldwide action to combat climate change, protect ecosystems, and ensure human well-being in light of these ecological changes is highlighted by their cumulative effects.

3.3. How Bangladesh Socially, Economically and Environmentally Affected by Climate Change

In Bangladesh, climate change has far-reaching social, economic, and ecological consequences. The nation's sensitivity to natural disasters like floods, cyclones, and rising sea levels worsens the degradation of the environment and lifestyles; this is especially true for vulnerable populations who depend on agriculture and natural resources for their survival (Washim, Arefin, & Nusrat, 2022). These climate changes are impeding sustainable development initiatives because they impact on crucial economic sectors like banking, tourism, and agriculture (Chowdhury, 2023). High transaction costs and the default mentality within the financial industry are two of the issues that continue to exist, even though there are programs like GF that try to reduce environmental hazards

(Zheng, Siddik, Masukujjaman, & Fatema, 2021; Zheng, Siddik, Masukujjaman, Fatema, et al., 2021). In addition to other challenges, Bangladesh lacks a complete legislative framework that would allow for the successful integration of green technology and the mitigation of climate vulnerabilities (ADB, 2018). However, there are still challenges to overcome, such as a lack of knowledge and legislative frameworks, before renewable energy sources can really help reduce emissions of GHGs and our dependence on fossil fuels (Askary, Hai, Showmik, Kader, & Rahman, 2022). Although there are still obstacles to overcome, such as identifying the best plant location and ensuring a steady supply of biomass, biogas produced by anaerobic digestion offers a potential solution to both the energy crisis and environmental problems (Sharmin, Yabar, & Richards, 2023). Women are one of the most disadvantaged groups who face the most significant impacts of CC since renewable energy use and access to electricity are linked to gender equality and the process of decision-making (Binyamin, Slama, & Zafar, 2024). However, green banking projects may require assistance in coordinating stakeholders and diversifying product offerings to effectively integrate environmental considerations into financial decisions, despite their potential benefits (Karim, 2020). Despite all these hurdles, it becomes imperative that civil society, financial institutions, and politicians come together to create ways for Bangladesh to become a country that is sustainable, safe, and prosperous through climate change induced adversities.

4. GF FOR MITIGATING CLIMATE CHANGE

Green financing is an integral part of the framework meant to help communities break free from the poverty cycle and is a breakthrough kind of solution implemented to fight climate change at its core. This comprehensive strategy, however, is a multi-dimensional approach that gives investment direction through financial instruments and processes such as green bonds, loans, funds, taxation, and subsidies, which promote environmentally friendly initiatives. Financial and environmental activism are becoming very prominent in the worldwide fight to reduce CC and for sustainable global development. The (Alharbi, Al Mamun, Boubaker, & Rizvi, 2023) devise a study in 2023. This addresses the environmental issues from multiple angles and, at the same time, makes a community more robust economically. A flurry of studies endorses the fact that GF enhances the transmission of renewable energy worldwide, reduces carbon emissions and forms global sustainable development programs (Haseli et al., 2024). The research by Numan et al. (2023) which examines the components influencing ecological footprints, GF, and technological improvement, is reported to be reducing environmental pollution. Trivedi et al. (2023) stress the need for broad-based and inclusive policies and laws when it comes to an easy transition to renewable power production and development in different countries. In order to achieve low-carbon development, Liu et al. (2024) shed light on the intricate relationship between nuclear energy consumption and carbon emissions. So, they suggest promoting or enhancing the deployment of renewable energy sources in addition to GF projects.

Their study examining mutual causes of GF and environment quality in Asian countries (Khan et al., 2022) reveals the negative impact of green money on ecological footprints: they suggest that the said issues should be resolved with the help of low-carbon initiatives and GF in order to strategically develop sustainably. (Zheng, Feng, & Chang, 2023), attribute policymakers' fostering of green financing systems as a critical factor for developing for renewable energy innovation; however, the authors demonstrate a strong association between these systems and renewable energy innovation. A critical aspect of the article (where Elsherif (2023)) shows that the world of GF has the power to achieve the vision of Zero- GHGs emissions (Egypt's efforts to insert GF ideas into the banking industry are being unexplained here). Mobilization of green financing and mitigation of energy poverty are spelled out in the research by Mohsin, Dilanchiev, and Umair (2023) who also look at green financing and fund portfolios in EU countries. Tan, Aviso, and Ng (2019), who give optimization models on investment prioritization for the advancement of GE technology, is a notable example that emphasizes the vital role of decision support tools utilized by policymakers and other stakeholders in commercializing green technologies. In their green transition study for China's power generating sector, (Lin, Liao, & Jia, 2023) focus on the crucial role of green financing and give solid

policy suggestions on how to promote GF and assist the country to be freed from carbon emissions. As stated by Voumik, Rahman, Nafi, et al. (2023) who show a theoretical framework constructed on the foundations of environmental Kuznets curve theory, green financing ensures the transition to low-carbon energy and policies are achieved. Green technology innovation, natural resource rent, and GF from the research work of GE. Sun, Bao, and Taghizadeh-Hesary (2023) are evaluated to develop the most appropriate policies that encourage cleaner energy use and GF. GF and alternative energy are the main pillars directing the finance sector and the banks in mitigating the effects of CC and safeguarding banks (Kamran, 2020).

This paper intends to assist the policymakers in the challenges of the negotiations for sustainable development by Behera, Behera, and Sethi (2024) exploring the intricate bondage between low carbon emissions, renewable energy, political stability, and future budget and these impacts on carbon dioxide pollution. Their work on GF's role in the climate actions of India and China suggests policy innovations to hasten the progress on sustainable development (Shah, Jirakiattikul, Techato, & Mudbhari, 2023). The key to overcoming changes in the climate as well as saving energy is the powerful domain.

4.1. How Bangladesh Can Mitigate CC with the Help of GF

Due to CC, Bangladesh has experienced the most adverse weather chronicle, with sea levels heightening and increased environmental degradation. The government gets a prompt opportunity to solve crucial issues and develop a sustainable movement using green money. Numerous programs referred to as "GF" seek to ensure that financial resources flow in the direction of sustainable growth. Studies reveal that green financing can propel Bangladesh towards unprecedented progress in reducing its carbon footprint and expanding its use of green resources (Chowdhury, 2023). Applying green taxes and scaling down subsidies to companies and businesses to switch to environment-friendly technologies (ADB, 2018). This will allow the plants to actively reduce their carbon footprint and overall ecological effects on the environment.

Moreover, Bangladesh can increase its renewable energy sources and reduce its reliance on non-renewable sources by expanding its ecology park, including solar, wind, and water-generating projects, through financial assistance from green programs (Washim et al., 2022). Creating ecosystem restoration projects, planting trees, and implementing sustainable agricultural practices may be the most reliable way for communities already endangered by climate change to adapt to the consequences (Kumar, Talukder, Kabir, & Kaiser, 2023). Green financing may contribute to Bangladesh becoming more resilient to climate change via infrastructure building that can survive climate change and subsequent reduction of natural disasters (Zheng, Siddik, Masukujjaman, Fatema, et al., 2021). In the first place, responsible finance can sophisticate itself, and funds will be made to align with achieving sustainable development goals when ESG factors are part of the investment decision-making. On the other hand, along with the challenges such as insufficient funds, poor institutional capacity, and tight regulations (Amin, Chowdhury, Jamasb, Khan, & Nepal, 2023) there are also specific issues to consider. The only way to eliminate this problem and make GF investments happen is for the employees of government agencies, banks, and civil society members to cooperate, Al Hassan (2021). The impacts of climate change on Bangladesh's inhabitants and ecosystem could be reduced. The country can enhance its future outlook if it involves itself in GF.

5. GE PRODUCTION FOR MITIGATING CC

Implementing GE is still a priority countermeasure in GHG mitigation since more and more data shows how powerful its impact could be and provides us with reliable solutions. The study by Kocur-Bera and Czyża (2023) on the vulnerability of the rural people in Poland's Mazura Basin Great Masurian Lakes Mesoregion calls for a community approach that include all the micro-groups within this ecosystem together with methods that can help the community to be resilient in the face of climate risks. In addition, the research undertaken on the islands of the Pacific also shows that GE is necessary for policy change and renewable sources are significant tools to solve the

problems of fuel shortage and climate change (Mohanty, 2012). South Asia's GHG emission assessments show how energy consumption, economic development, and environmental sustainability are compounded entities, each being impacted by the three others. The emphasis is on how green technology and efficiency measures reduce emissions (Tariq et al., 2022).

Moreover, studies on nuclear power as a building block in the framework of renewable energy industries have established that safety measures and collaborations with renewable energy options are the solution to the climate change war (Woo, 2018). According to a study employing panel data techniques (Wu et al., 2021) our research finding reveals that GF significantly impacts both economic development and environmental protection, regardless of the country's membership in the G7 or E7. Financial institutions, innovation of the carbon tax, and community-oriented trust funds are some possible solutions that can be considered for the issue of green programme funding if they follow Taghizadeh-Hesary and Yoshino (2020) ideas regarding renewable energy. Moreover, possibilities for carbon emission reduction and clean energy development projects have surfaced due to the combination of green financing and blockchain technology, chiefly in China, where cryptocurrency is used. Green bonds, which are financial instruments that promote low-carbon society, have to be studied using life cycle analysis where environmental implications might be obvious (Gibon et al., 2020).

Additionally, GF, clean energy, and Industry 4.0 are evolving as the foundation of a creative adaptation platform that entrepreneurs might employ to develop more people-centred and sustainable industrial innovations (Ng et al., 2021). Research using complex models and econometric techniques has shown that policies involving the inflow of foreign investments increase capital formation, promote trade openness, enhance human capital, and decrease CO₂ emissions. Inflation can lead to higher GF investments. Developments in the financial sector, economic diversity, ageing population, innovation in technologies, investment in renewable energy, and restructuring of industries are the main determinants of carbon pollution in China (Dong & Akhtar, 2022). This implies that the policies targeting the decrease in the emissions level should be based on these issues. Lin et al. (2023) and Niwalkar et al. (2023) conducted a study focusing on fitting green financing policies, financing efficiency, fiscal restructuring, industrial structure, and environmental consequences. These groups discovered that low oil prices were a boon to the environment, as this boosted the green economy, mainly benefiting firms in the renewable energy sector. Each of these studies has helped to build the case that GE generation is a critical element of the fight against CC and the broader sustainability agenda at the international level.

5.1. How Bangladesh Mitigate CC with the Support of GE

The Bangladeshi government's sustainable development goals include the implementation of environmentally friendly energy solutions in the context of the climate change issue. Bangladesh needs to implement solid mitigation and adaptation measures urgently because of its unique vulnerability to climate-related disasters. The three platform pillars of research, legislative frameworks, and international cooperation from the foundation of GE programs, which include renewable energy resources. The large-scale opportunities and needs for solar energy have led to significant technology adoption, especially in rural regions with the weakest intensity of grid connections. This achieves energy access and makes the ongoing rural electrification more practical (Washim et al., 2022). Although infrastructural and logistic problems remain, marine locations can benefit significantly from wind energy as a substitute for fossil fuels (Askary et al., 2022). Renewable energy sources (such as biogas, which develops from biodegradable waste) may play an essential role in empowering rural communities to use self-sustainable energy and decrease their dependence on conventional fuels (Sharmin et al., 2023). In the opinion of Uddin, Rahman, and Saha (2023), biomass energy, made from agricultural byproducts, decreases carbon emissions and establishes sustainable practices. The study supports this. Julia, Noor, and Kassim (2020) little power plants in Bangladesh's river basins and steep terrain areas are positioned to deliver clean energy and reliable power sources. However, misuse of hydroelectric power is currently occurring.

Nevertheless, GE gets its share of strikes with the challenges along the way. Constraints include financial and regulatory issues and technical problems (ADB, 2018). To enable everyone to explore clean energy sources, we must develop innovative policies to overcome these limitations and collaborate to create an ecosystem that encourages investments in innovations that promote green energy (Al Hassan, 2021). Aside from decreasing its susceptibility to climate change, Bangladesh could attain its economic and social development targets by exploiting the revolutionary capacity of green power and leading nationally in sustainable development.

6. INTERNATIONAL ORGANIZATIONS ROLE TO COMBAT CLIMATE CHANGE

To fight against CC, international organizations are taking several effective initiatives and continuously providing funds to the most vulnerable countries so that they can cope with this devastating giant.

6.1. International Organizations and Climate Action

International organizations serve as indispensable catalysts in the global fight against climate change. These bodies offer a platform for coordinated action, establish international standards, mobilize funding, and facilitate crucial knowledge exchange. Among the most prominent players are the United Nations Framework Convention on Climate Change (UNFCCC), the World Bank (WB), the International Monetary Fund (IMF), and the International Renewable Energy Agency (IRENA), as explained in Figure 1.

The UNFCCC serves as the central multilateral forum for addressing climate change (UNFCCC, 2023). It has provided a platform for landmark agreements such as the Kyoto Protocol and the Paris Agreement. The Kyoto Protocol, adopted in 1997, was the first international agreement to set legally binding emission reduction targets for industrialized countries (Gupta, 2010). While its impact was limited, it established a precedent for binding international climate commitments. Adopted in 2015, the Paris Agreement surpassed the Kyoto Protocol by uniting nearly all nations to limit global warming to well below 2°C and aim for 1.5°C (UNFCCC, 2016). This agreement emphasizes Nationally Determined Contributions (NDCs), which outline each country's climate action plans, creating global accountability and a common goal.

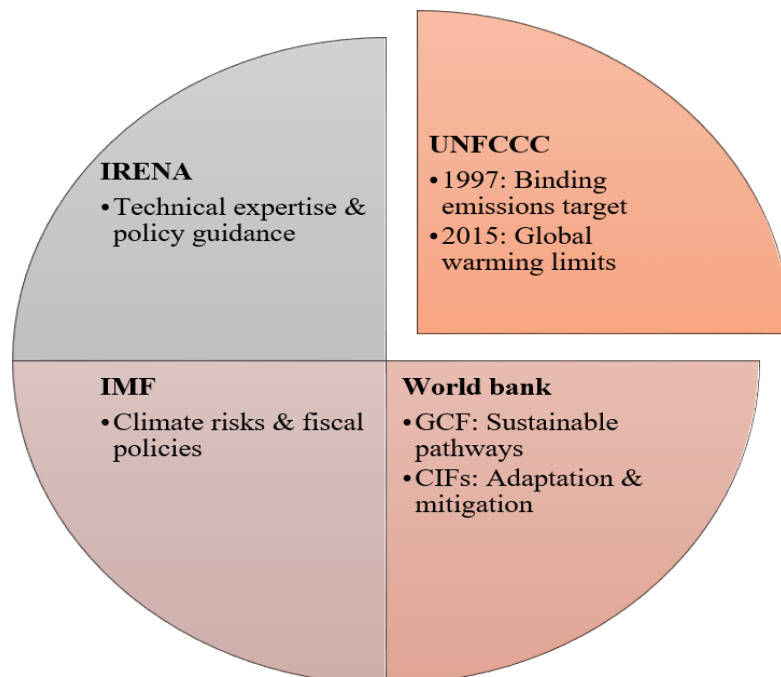


Figure 1. International organizations and climate action.

Financial institutions like the WB play a crucial role in enabling investments that support climate-resilient development, especially in developing countries. The WB Group is a significant source of climate finance, with ambitious targets to scale up its climate action commitment (World Bank, 2019). Through initiatives like the Green Climate Fund (GCF) and Climate Investment Funds (CIFs), the WB channels billions of dollars into climate adaptation and mitigation projects globally. The GCF specifically aims to facilitate a paradigm shift towards sustainable pathways in developing countries, prioritizing the most vulnerable communities.

The IMF tackles climate change mitigation from a macro perspective by embedding climate risks into its vertical scanning commissions (IMF, 2024). The fact that the IMF mentions the negative socio-economic ramifications of climate change, including the financial considerations of a progressing green economy, is noteworthy. Among the many impacts their work on carbon pricing and funding climate-resilient infrastructure has on the world is that the two have to be integrated from the policy area to simultaneously achieve both the fiscal sustainability and climate change agenda (Semmler, Braga, Lichtenberger, Toure, & Hayde, 2021).

The IRENA is a global centre for supporting renewable energy utilization, reaching every country where the sun, wind, or hydroflows can be used (IRENA, 2023c). It deals with renewables in all manifestations; as a result, it provides countries with technical assistance, from policy implementation to capacity building. IRENA focuses on replicating a successful model, inspires other agents, and advances favourable conditions for widespread, industrial-scale renewable energy implementation. Recent research shows that the renewable energy sector has grown significantly, and solar and wind power are leading the clean transition in modern energy systems (IRENA, 2023d).

As the efforts of international organizations culminate in concrete implications on climate action—nationally and on the international level—the significance of international organizations in climate action cannot be overemphasized. Even though these organizations face significant issues regarding the growth of the global agenda, the need to fill in the gap in the coordination of the effort, and the provision of a logical and comprehensive framework for climate finance, their role has been crucial not only in terms of development of action on climate change but also through the set of rules on environmental ethics. How to improve the effectiveness of international organizations in coping with global warming remains a critical issue for future research on enhancing their role, accountability, and climate justice.

6.2. Mobilizing Funds for Climate Action through Green Financing

The increasing gravity of the climate crisis has made the search for novel financial mechanisms a vital factor in the faster movement to a low-carbon society. GF provides the necessary tools and mechanisms to relocate investment towards eco-friendly projects and the mitigation of environmental degradation. The international organizations that serve as the arena for funding are central to implementing climate centred activities on a large scale.

International organizations have greatly accelerated the process of environmentally approved green bonds by designing and disseminating standards. From Figure 2, the WB was the first to hatch this concept in 2008 when the green bond was issued. Green bonds, which are the debt instruments dedicated to climate or environment-related projects, have expanded the range of green capital options available to investment. The green bond market has been increasing at a fast pace. During 2013, global bonds, which were issued worth \$11 billion, went up to over \$517 billion by 2021 (Rahman et al., 2023). Growth is due to the increasing investors' interest in alternative asset classes that create financial and environmental gains.

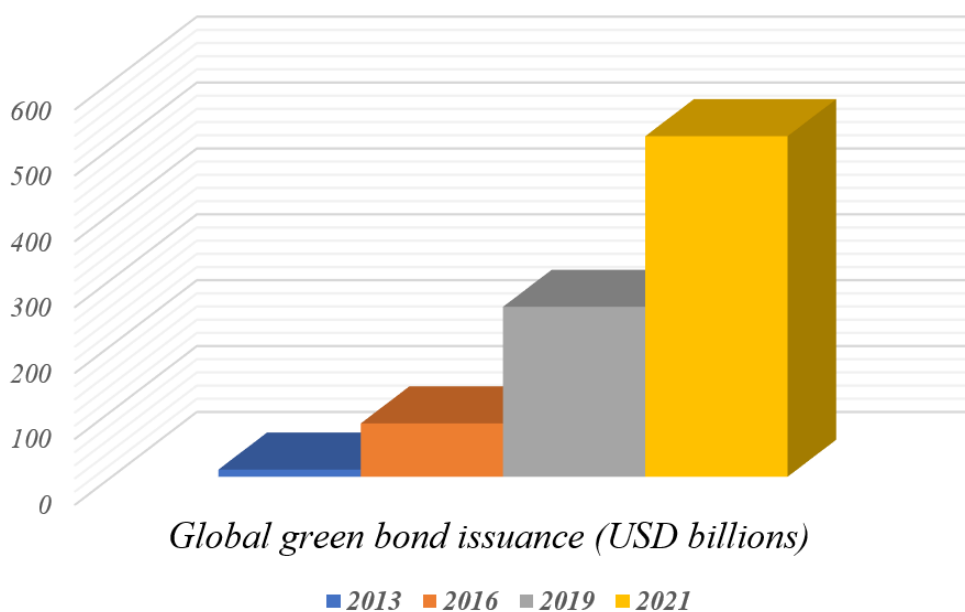


Figure 2. Climate bonds initiative.

In this direction, international institutions have been addressing green market integrity and transparency in allocating GF resources. They have developed indicators and frameworks for this. The Green Bond Principles (GBP), a voluntary set of principles laid down by the International Capital Markets Association (ICMA) in 2021, have provided the guidelines for transparency and reporting to establish best practices for issuing, reporting, and managing green bonds. These standards can bolster investor confidence and mitigate the risks associated with 'greenwashing', thereby clarifying the role of finance in achieving climate mitigation and adaptation objectives.

Developing countries' tendency to create an enabling environment that could attract eco-friendly finance creates another difficulty. The capacities of international organizations are significant, as they assist governments and funding institutions in developing GF policies, framing regulations, and building pipelines for projects. The UNEP is offering training and technical support that will guide many nations on market conditions, thereby facilitating an increase in green capital (UNEP, 2024b). Partner with governments, community organizations, and private sector entities to train labourers for renewable projects, risk assessment, and crafting financial tools suitable for local contexts.

The part played by international organisations in promoting green financing is the investor's attention to investments in climate change solutions from various aspects. Green bonds were a vehicle for financing projects in renewable energy, energy efficiency, and, more recently, clean transportation, green buildings, sustainable agriculture, and even adaptation to the impacts of climate change (Sadiq, Nonthapot, et al., 2022). The collective emphasis on such investments will enable economies to carbonize while also contributing to the resilience and creation of new options that will absorb mainstream sustainable development trends and thinking.

However, significant challenges remain in achieving the full potential of GF. Scaling up investments to match the urgency of the climate crisis demands greater commitment from institutional investors, the private sector, and governments (Rahman, Voumik, Rahman, & Majumder, 2024; Voumik, Rahman, Rahman, et al., 2023). Further innovations in green financial instruments, such as sustainability-linked bonds and blended finance models, will be crucial for addressing diverse financing needs. Continued efforts by international organizations to enhance standardization, address market barriers, and provide targeted support to developing countries will be essential in accelerating the green finance revolution.

6.3. Growth Impact of Solar Energy Advancements

In the last few decades, the development of solar photovoltaic (PV) energy has accelerated very quickly, revolutionizing the global energy structure. In 2000, the world's total installed PV solar capacity was less than 0.1 GW. In 2020, the figure had increased by over 700 GW, which clearly showed the intention of development fueled mainly by cooperation and financing initiatives (IRENA, 2023e). In 2022, solar capacities were estimated to be more than 1 TW installed worldwide, demonstrating the expanding uptake of solar as a reliable and cost-competitive energy source (IRENA, 2023b).

Table 1. Global installed capacity.

Year	Global installed capacity
2000	Below 1 GW
2020	Over 700 GW
2022	Estimated to exceed 1 TW

Source: IRENA (2023d).

The mentioned Table 1 presents the efficacy of those multilateral activities concerning technology research, policymaking, knowledge transfer, and financial support, thus making solar energy an integral cog of the clean energy transition.

7. IMPACT OF INTERNATIONAL ORGANIZATIONS ON BANGLADESH'S CLIMATE CHANGE MITIGATION EFFORTS

However, in a low-lying deltaic zone, Bangladesh has the most significant CC risks, such as cyclones, flooding, and rising sea levels. To handle these limitations, international bodies become the fundamental organizations in allocating funds, applying technical knowledge, and giving policy recommendations.

The country bases its climate actions on the UNFCCC. The country has been working on the National Determined Contributions (NDCs) and National Adaptation Plans (NAPs) with UNFCCC support (Laudari, Aryal, Bhusal, & Maraseni, 2021). This planning is represented by the various policies that constitute Bangladesh's climate goals and strategies, and they mainly focus on disaster risk reduction, renewable energies, and climate-resilient agriculture. The UNOCCC also supports exchanging beneficial examples, knowledge, and climate technology transfer to enable Bangladesh's adoption and mitigation.

The WB is the prominent financier of climate funds and provides technical assistance for Bangladesh. The Climate Investment Funds (CIFs) are utilized in specific projects that improve climate resilience in coastal zones, increase energy input from renewable sources, and promote energy efficiency across the country (Rahman, Majumder, & Debbarman, 2020). Besides, the Green Climate Fund (GCF) stores the national budget to some extent to improve the country's capacity to adapt to abrupt climate change through disaster-resilient housing and an early warning system (Voumik, Rahman, Rahman, et al., 2023). The Coastal Embankment Improvement Project (CEIP), a WB-financed scheme, demonstrates this (Forni, 2015).

The IMF oversees the economic evaluation and policy recommendations for Bangladesh and includes climate change considerations in its analyses (IMF, 2024). IMF supports the identification of the economic risks potentially caused by climate change and offers various fiscal instruments, such as carbon taxes or investments in climate-resilient infrastructure. One of the strengths of this approach is that it ensures that Bangladesh sets up economic policies as a priority alongside fulfilling its climate obligations to propel a transition into a green and sustainable economy.

It is IRENA's promise that Bangladesh will have an improved renewable energy sector. It supplies knowledge and information on determining renewable energy potential, developing the policy framework, and building the

power section's capacity (IRENA, 2023a). Table 2 presents the solar capacity in Bangladesh. IRENA's contribution becomes a key factor as Bangladesh embarks on providing more renewable power options to its citizens.

Table 2. Growth of installed solar PV capacity in Bangladesh.

Year	Installed capacity (IC)
2015	~200
2022	~700 (Estimated)

Source: IRENA (2023c) Bangladesh power development board (2024).

International collaboration has fueled the deployment of off-grid solar home systems and the recent development of utility-scale solar farms, driving this progress.

These combined efforts by international organizations contribute significantly to Bangladesh's CC mitigation efforts. The financing, technological support, and policy guidance provided by these institutions help Bangladesh build resilience, develop a low-carbon economy, and move towards a more sustainable future.

8. DEVELOPED COUNTRIES AND SOUTH ASIAN COUNTRIES HOW ARE COMBATING CLIMATE CHANGE

Developed countries and South Asian nations approach climate change with contrasting priorities and resources. Developed countries, often bearing greater historical responsibility for GHGs emissions, possess stronger financial and technological capacities. They are expected to lead ambitious emission reduction targets, support technology transfer, and provide financial assistance to developing nations to accelerate the global transition. South Asian countries, highly vulnerable to climate change impacts, face the unique challenge of balancing climate action with urgent economic development and poverty reduction needs. They emphasize the principle of climate justice, demanding equitable support from developed nations (The Daily Star, 2022).

These regions have different green financing landscapes. Developed countries have seen large-scale green bond issuance, with nations like France and Germany being leading issuers. Green investment funds targeting diverse climate solutions have also proliferated. South Asian countries are demonstrating growing interest in green bonds, with India emerging as a regional leader. Development banks like the Asian Development Bank (ADB) play a crucial role in funding renewable energy and climate adaptation projects. However, challenges remain in significantly scaling up GF due to market barriers and limited investor awareness in South Asia.

In terms of GE production, developed countries have witnessed a rapid expansion of solar and wind energy, driven by supportive policies, technological advancements, and declining costs. Nuclear power remains a significant contributor in some nations. South Asian countries are actively working to increase the share of renewables in their energy mix, with India setting ambitious targets. Hydropower remains an important source in the region, but its expansion faces environmental and social considerations. Both developed and South Asian countries are investing in energy storage solutions to address the variability associated with renewables. Table 3 presents the electricity from renewable energy sources. However, South Asian nations often encounter challenges with grid integration and accessing financing for large-scale renewable projects (UNEP, 2017).

Table 3. Renewable energy share in electricity generation (2021).

Country/Region	Solar (%)	Wind (%)	Total renewable's (%)
Germany	10.9	25.6	47.6
European union (Avg.)	5.9	15	38
India	5.5	1.3	12.1
Bangladesh	1.6	0.1	3.3

Source: IRENA (2023d) BP statistical review of world energy (2022).

9. INITIATIVES OF BANGLADESH TO MITIGATE CLIMATE CHANGE

Bangladesh, though vulnerable to climate change, sensitively takes appropriate steps for mitigation. A fundamental aspect, however, is the inclusion of climate change issues in national development programs. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP), formulated in 2009, is the overall guiding principle of the country's climate actions (Islam, Shaw, & Mallick, 2013). To date, Bangladesh has also developed its NDCs under the Paris Agreement, which entails a reduction in emissions and adaptation policy.

For this, Bangladesh uses both local and global funding. In terms of foreign finance, the government of Bangladesh has established a Bangladesh Climate Change Trust Fund (BCCTF) that channels money to adaptation and mitigation activities per sector. Although Bangladesh uses the Green Climate Fund (GCF) and the Climate Investment Fund (CIF) as a financial source, it still struggles to find money. Bangladesh uses these funds to undertake a variety of projects, such as facilitating storm and cyclone shelters, creating climate-resistant infrastructures, and bringing in renewable energy systems.

Bangladesh can do well by making solar and wind energy just part of its energy mix to become less dependent on fossil fuels. Far-flung rural areas widely use photovoltaic technology, which provides essential electrical services to off-grid solar home systems. Decisive authorities are responsible for the growth of the energy mix's renewables level. EEF of CIF is propelling Bangladesh towards the clean energy era, as per SREP (Climate Investment Funds, 2015).

Beyond solar energy, Bangladesh is exploring other renewable sources like wind and biomass. Various industries are also implementing energy efficiency measures to optimize energy consumption and reduce emissions. Table 4 presents the climate mitigation projects in Bangladesh. Bangladesh also recognizes the importance of nature-based solutions, with projects focused on afforestation, mangrove restoration, and sustainable agriculture to enhance carbon sequestration and build resilience.

Table 4. Bangladesh's key climate mitigation projects.

Project/Program	Funding source	Focus areas
Bangladesh climate change resilience fund (BCCRF)	Government of Bangladesh, UK, Sweden, EU	Community-level adaptation projects, disaster preparedness
Coastal embankment improvement project (CEIP)	World bank	Enhancing embankments, reducing flood risks
Scaling up renewable energy program (SREP)	Climate investment funds (CIFs)	Solar energy deployment, grid integration
Nature-based solutions initiatives	Various (Domestic & international)	Afforestation, mangrove restoration, sustainable agriculture

10. BANGLADESH FACE CHALLENGES AND BARRIERS FOR MITIGATING CC

Bangladesh struggles with a battle of complex problems on its way to CC action. A budget that is smaller in size is often very restricting. The BCCTF indicates the commitment, but it is instead the amount of money that seems not to be worthy of the big-scale projects. For instance, the funds required for mitigation and adaptation programs can far exceed the existing domestic resources (Uddin, 2006). Despite the pledges and promises, the difficult task of finding international character in climate finance has remained challenging due to the cumbersome procedures and deep needs among the developing nations.

Encouraging the growth and use of these GE technologies also presents challenges. While solar energy has seen improvements, the deployment of large renewable system sizes to decrease the use of fossil fuels substantially still incurs significant investment. Some obstacles presented in Table 5 include the substantially limited grid capacities to take up intermittent energy sources, land acquisition complexities, technology transfer, and capacity building (Islam & Khan, 2017).

Table 5. Bangladesh faces challenges.

Challenges	Description
Financial constraints	Limited domestic resources, complex access to international climate finance.
Technological barriers	Grid integration challenges, need for technology transfer and capacity building in renewables.
Institutional & policy gaps	Siloed approach across government agencies, evolving regulatory frameworks for green investment.
Climate vulnerability	Frequent natural disasters disrupt mitigation focus, complex adaptation needs.
Social & economic constraints	Balancing poverty alleviation with climate action, concerns about ensuring equitable energy access.

Institutional and policy barriers could potentially impede progress. In some cases, inter-ministerial and cross-agency coordination regarding climate action might be imperfect. Besides, establishing strong regulatory institutions and funding mechanisms to attract sufficient private sector investments are ongoing initiatives (Rashed, Alam, & Fahim, 2014).

The climate change impacts in Bangladesh worsen these difficulties. Frequent disasters and extreme weather conditions prevent sustainability efforts as resources and policy plans concentrate on short-term adaptation and emergency response. Also, the fact that Bangladesh is a low-lying deltaic region with numerous rural populations living in flood-prone zones further exacerbates the challenges of climate mitigation. Furthermore, it's crucial to consider social and economic constraints. The resolution of climate action and poverty eradication is a tricky balance. Fears of job losses in conventional industries and of guaranteeing affordable energy for disadvantaged groups are stumbling blocks to the shift to a green economy (Sarker et al., 2020).

11. CONCLUSION AND IMPLICATIONS

This study aims to evaluate ways of mitigating climate change with the support of GF and GE in Bangladesh. In this case, the study identified several crucial factors that cause climate change, such as human activities, fossil fuel burning, GHG emissions, and so on. The main impacts of climate change are global warming, loss of natural habitats and biodiversity, food insecurity, immigration, and human diseases. Two environmentally friendly tools, like GF and GE, are used to fight climate change. GF, comprising financial instruments like green bonds and loans, finances significant investments in environmental projects, particularly renewable energy, that promote the transition to a greener, low-carbon economy and ultimately help to combat climate change. Solar, wind, hydropower, biomass, and biofuels are the common GE production technologies in Bangladesh, which can play a pivotal role in reducing climate change. The research shows that GF contributes to investment in GE projects, innovation in clean energy technologies, investment risk management, and energy transitions in Bangladesh. The research has integrated the relationship between GF and GE. The study recommends some valuable implications for the Bangladesh government, policymakers, and other stakeholders taking effective initiatives to protect Bangladesh from the gulf of devastating climate change.

The world map identifies Bangladesh as one of the climate change vulnerable countries. Hence, to combat climate change, the Bangladesh government should build up appropriate new policies, develop effective regulations, and recheck the existing policies for promoting GF and GE production. To improve environmental quality, the government should adopt more GF-Supportive initiatives and exploits the financial resources in an effective way. The government could enact GE and enforce and suggest to municipal bodies that they use solar power systems and energy-saving technologies in each building to build smart cities. Moreover, the government could partner with other countries and international organizations like the WB, IMF, OECD, IFC, ADB, and so on to exploit FDI in GE production. Additionally, the government should invest more in R&D to invent new GE technologies, grant incentives in GE market sectors to promote businesses, and organize a national prize-giving ceremony for the top contributors, which will enable companies to produce and sell more GE technologies. Apart from these, the

government has to provide tax-exemption facilities to green financing and GE-related companies. To implement the government's planning and initiatives, the central bank should come forward. Bangladesh Bank should focus on inventing new GF instruments and ensuring that they are available in commercial banks. Moreover, the bank ought to build up new policies for the financial institutions so that they can increase CSR expenditures and spend a large portion on GE production in their own institutions. When the banks provide their customers with loans, they should justify the green image of the companies. After providing finance to the different business sectors, particularly the manufacturing industry, the banks should track the energy utilization procedures and waste management system. In addition to governing bodies and financial institutions, the general public is also responsible for focusing on and utilizing GE production. They could use solar power systems and lower their reliance on nonrenewable energy, which is detrimental to the environment and causes climate change. In this regard, the government could also create virtual advertising to encourage people to focus on renewable energy production. Further study will follow the empirical evidence and econometric and statistical analysis in this issue.

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REFERENCES

- Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, 29(28), 42539-42559. <https://doi.org/10.1007/s11356-022-19718-6>
- ADB. (2018). *Green finance in Bangladesh: Policies, institutions, and challenges Asian development bank institute*. Retrieved from <https://www.adb.org/publications/green-finance-bangladesh-policies-institutions-challenges>
- Ahmed, N., Areche, F. O., Sheikh, A. A., & Lahiani, A. (2022). Green finance and green energy nexus in ASEAN countries: A bootstrap panel causality test. *Energies*, 15(14), 5068. <https://doi.org/10.3390/en15145068>
- Ainou, F. Z., Ali, M., & Sadiq, M. (2023). Green energy security assessment in Morocco: Green finance as a step toward sustainable energy transition. *Environmental Science and Pollution Research*, 30(22), 61411-61429. <https://doi.org/10.1007/s11356-022-19153-7>
- Akter, N., Siddik, A., & Mondal, M. A. (2018). Sustainability reporting on green financing: A study of listed private sustainability reporting on green financing: A study of listed private commercial banks in Bangladesh. *Journal of Transportation Technologies*, 12(1), 14-27.
- Al Hassan, M. (2021). A study on green and sustainable-factory building in terms of design, planning, construction & operation to reply the energy crisis in Bangladesh urban context. *Research & Reviews: Journal of Architectural Designing*, 3(2), 1-6.
- Alam, K. (2015). Farmers' adaptation to water scarcity in drought-prone environments: A case study of Rajshahi District, Bangladesh. *Agricultural Water Management*, 148, 196-206. <https://doi.org/10.1016/j.agwat.2014.10.011>
- Alauddin, M., & Sarker, M. A. R. (2014). Climate change and farm-level adaptation decisions and strategies in drought-prone and groundwater-depleted areas of Bangladesh: An empirical investigation. *Ecological Economics*, 106, 204-213. <https://doi.org/10.1016/j.ecolecon.2014.07.025>
- Alharbi, S. S., Al Mamun, M., Boubaker, S., & Rizvi, S. K. A. (2023). Green finance and renewable energy: A worldwide evidence. *Energy Economics*, 118, 106499. <https://doi.org/10.1016/j.eneco.2022.106499>
- Amin, S. B., Chowdhury, M. I., Jamasb, T., Khan, F., & Nepal, R. (2023). *Green energy finance and gender disparity: The case of mountain areas in Bangladesh*. Retrieved from Copenhagen Business School, Working Paper No. 2023-02:

- Andreopoulou, Z. (2016). Green ICTs for climate change mitigation and energy sustainability: EU challenge. *Quality-Access to Success*, 17, 492-496.
- Askary, M. A., Hai, T. B., Showmik, S. S. K., Kader, M. A., & Rahman, M. T. (2022). The prospect of green energy and technology in Bangladesh. In *Journal of Physics: Conference Series (Vol. 2312, No. 1, p. 012009)*. IOP Publishing.
- Bates, B. (2008). *Climate change and water: Technical paper of the intergovernmental panel on climate change* [7.11 MB]. Geneva: IPCC Secretariat.
- Battisti, D. S., & Naylor, R. L. (2009). Historical warnings of future food insecurity with unprecedented seasonal heat. *Science*, 323(5911), 240-244. <https://doi.org/10.1126/science.1164363>
- Bdnews 24. (2023). *Bangladesh records its hottest day of the season*. Retrieved from <https://bdnews24.com/bangladesh/cscur62kxj>
- Behera, B., Behera, P., & Sethi, N. (2024). Decoupling the role of renewable energy, green finance and political stability in achieving the sustainable development goal 13: Empirical insight from emerging economies. *Sustainable Development*, 32(1), 119-137. <https://doi.org/10.1002/sd.2657>
- Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change? *Global Environmental Change*, 21(1), 25-33. <https://doi.org/10.1016/j.gloenvcha.2010.09.012>
- Binyamin, S. S., Slama, S. A. B., & Zafar, B. (2024). Artificial intelligence-powered energy community management for developing renewable energy systems in smart homes. *Energy Strategy Reviews*, 51, 101288.
- Borowski, P. F. (2022). Mitigating climate change and the development of green energy versus a return to fossil fuels due to the energy crisis in 2022. *Energies*, 15(24), 9289. <https://doi.org/10.3390/en15249289>
- Byrne, J., Hughes, K., Rickerson, W., & Kurdgelashvili, L. (2007). American policy conflict in the greenhouse: Divergent trends in federal, regional, state, and local green energy and climate change policy. *Energy Policy*, 35(9), 4555-4573. <https://doi.org/10.1016/j.enpol.2007.02.028>
- Cardoso, S. S., Cartwright, J. H., & Huppert, H. E. (2020). Stokes, Tyndall, Ruskin and the nineteenth-century beginnings of climate science. *Philosophical Transactions of the Royal Society A*, 378(2174), 20200064.
- Chen, X., & Chen, Z. (2021). Can green finance development reduce carbon emissions? Empirical evidence from 30 Chinese provinces. *Sustainability*, 13(21), 12137. <https://doi.org/10.3390/su132112137>
- Chien, F., Ajaz, T., Andlib, Z., Chau, K. Y., Ahmad, P., & Sharif, A. (2021). The role of technology innovation, renewable energy and globalization in reducing environmental degradation in Pakistan: A step towards sustainable environment. *Renewable Energy*, 177, 308-317. <https://doi.org/10.1016/j.renene.2021.05.101>
- Chin, M.-Y., Ong, S.-L., Ooi, D. B.-Y., & Puah, C.-H. (2024). The impact of green finance on environmental degradation in BRI region. *Environment, Development and Sustainability*, 26(1), 303-318. <https://doi.org/10.1007/s10668-022-02709-5>
- Chowdhury, M. M. (2023). Green finance and bank performance: Evidence from Bangladesh. *International Journal of Multidisciplinary Research and Analysis*, 6(6), 2354-2362. <https://doi.org/10.47191/ijmra/v6-i6-28>
- Climate Investment Funds. (2015). *Investing in Bangladesh*. Retrieved from <https://www.climateinvestmentfunds.org/country/bangladesh>. [Accessed 17 Nov. 2019]
- Dong, X., & Akhtar, N. (2022). Nexus between financial development, renewable energy investment, and sustainable development: Role of technical innovations and industrial structure. *Frontiers in Psychology*, 13, 951162.
- Dudman, K., & De Wit, S. (2021). An IPCC that listens: Introducing reciprocity to climate change communication. *Climatic Change*, 168(1), 1-12. <https://doi.org/10.1007/s10584-021-03186-x>
- Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Kadner, S., Minx, J. C., Brunner, S., . . . Blanco, G. (2014). *Technical summary*. In: *Edenhofer O, Pichs-Madruga R, Sokona Y, Farahani E, Kadner S, Seyboth K, Adler A, Baum I, Brunner S, Eickemeier P, Kriemann B, Savolainen J, Schlömer S, von Stechow C, Zwickel T, Minx JC (Eds.), Climate change 2014: Mitigation of climate change. Contribution of working group III to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, USA: Cambridge University Press.
- Elsherif, M. (2023). Green financing as a tool to mitigate climate change for sustainable development: An insight form Egypt. *International Journal of Economics and Financial Issues*, 13(3), 33-45. <https://doi.org/10.32479/ijefi.14235>

- EU. (2023). *Global gateway: EU and Bangladesh sign €400 million for renewable energy and launch negotiations on a new Partnership and Cooperation Agreement*. Retrieved from https://www.eeas.europa.eu/delegations/bangladesh/global-gateway-eu-and-bangladesh-sign-%E2%82%AC400-million-renewable-energy-and-launch-negotiations-new-0_en?s=164
- Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. W. (2020). Strategies for mitigation of climate change: A review. *Environmental Chemistry Letters*, 18, 2069-2094. <https://doi.org/10.1007/s10311-020-01059-w>
- Forni, M. S. (2015). *Bangladesh - coastal embankment improvement project - phase I (CEIP-I): P128276 - implementation status results report: Sequence 02 (English)*. Washington, D.C: World Bank Group.
- Gibon, T., Popescu, I.-Ș., Hitaj, C., Petucco, C., & Benetto, E. (2020). Shades of green: life cycle assessment of renewable energy projects financed through green bonds. *Environmental Research Letters*, 15(10), 104045. <https://doi.org/10.1088/1748-9326/abaa0c>
- Godwin, B., & Author, O. (2022). *Greenhouse effect does not exist. Authorea Preprints. Green Climate Fund. (2020, February 12). About GCF. Green Climate Fund*. Retrieved from <https://www.greenclimate.fund/about>
- Gouldson, A., Colenbrander, S., Sudmant, A., Papargyropoulou, E., Kerr, N., McAnulla, F., & Hall, S. (2016). Cities and climate change mitigation: Economic opportunities and governance challenges in Asia. *Cities*, 54, 11-19. <https://doi.org/10.1016/j.cities.2015.10.010>
- Gupta, J. (2010). A history of international climate change policy. *Wiley Interdisciplinary Reviews: Climate Change*, 1(5), 636-653. <https://doi.org/10.1002/wcc.67>
- Haseli, G., Deveci, M., Isik, M., Gokasar, I., Pamucar, D., & Hajiaghaei-Keshteli, M. (2024). Providing climate change resilient land-use transport projects with green finance using Z extended numbers based decision-making model. *Expert Systems with Applications*, 243, 122858. <https://doi.org/10.1016/j.eswa.2023.122858>
- Hasib, E., & Chathoth, P. (2016). Health impact of climate change in Bangladesh: A summary. *Current Urban Studies*, 4(01), 1. <https://doi.org/10.4236/cus.2016.41001>
- Hossain, M. (2018). *Green finance in Bangladesh: Policies, institutions, and challenges*. Retrieved from ADBI Working Paper (No. 892):
- Hossain, M. (2019). Green finance in Bangladesh barriers and solutions. In *Handbook of Green Finance; Sustainable Development*. In (pp. 1-26). Singapore: Springer.
- IMF. (2024). *The IMF and climate change*. Retrieved from <https://www.imf.org/en/Topics/climate-change>
- IRENA. (2023a). *About IRENA*. *Irena.org*. Retrieved from <https://www.irena.org/aboutirena>
- IRENA. (2023b). *Bangladesh*. Retrieved from https://www.irena.org/IRENADocuments/Statistical_Profiles/Asia/Bangladesh_Asia_RE_SP.pdf
- IRENA. (2023c). *Renewable capacity statistics 2023*. Retrieved from www.irena.org. Available at: <https://www.irena.org/Publications/2023/Mar/Renewable-capacity-statistics-2023>
- IRENA. (2023d). *Renewable capacity statistiques 2023*. Retrieved from www.irena.org/publications
- IRENA. (2023e). *Renewable power generation costs in 2022*. Retrieved from www.irena.org. Available at: <https://www.irena.org/Publications/2023/Aug/Renewable-Power-Generation-Costs-in-2022>
- Islam, A., & Khan, M. M. A. (2017). Scaling up renewable energy in Bangladesh: Challenges and possibilities. *Journal of Environmental Management*, 191(1), 142-150.
- Islam, A., Shaw, R., & Mallick, F. (2013). *Bangladesh climate change strategy and action plans*. In: Shaw, R., Mallick, F., Islam, A. (Eds.), *Climate Change Adaptation Actions in Bangladesh. Disaster Risk Reduction*. Tokyo: Springer. https://doi.org/10.1007/978-4-431-54249-0_7.
- Islam, H., Rahman, J., Tanchangya, T., & Islam, M. A. (2023). Impact of firms' size, leverage, and net profit margin on firms' profitability in the manufacturing sector of Bangladesh: An empirical analysis using GMM estimation. *Journal of Ekonomi*, 5(1), 1-9. <https://doi.org/10.58251/ekonomi.1275742>
- Islam, M. T., & Nursey-Bray, M. (2017). Adaptation to climate change in agriculture in Bangladesh: The role of formal institutions. *Journal of Environmental Management*, 200, 347-358. <https://doi.org/10.1016/j.jenvman.2017.05.092>

- Julia, T., Noor, A. M., & Kassim, S. (2020). Islamic social finance and green finance to achieve SDGs through minimizing post harvesting losses in Bangladesh. *Journal of Islamic Finance*, 9(2), 119-128.
- Kamran, H. W. (2020). Climate change and bank stability: The moderating role of green financing and renewable energy consumption in Asean. *Talent Development & Excellence*, 12(2s), 3738-3751.
- Karim, R. (2020). Green banking practices in Bangladesh: Present scenario and future challenges. *Journal of Business Studies-Special Issue on Business and Sustainable Development*, 34-44. https://doi.org/10.1007/978-4-431-54249-0_7
- Khairunnessa, F., Vazquez-Brust, D. A., & Yakovleva, N. (2021). A review of the recent developments of green banking in Bangladesh. *Sustainability*, 13(4), 1904. <https://doi.org/10.3390/su13041904>
- Khan, M. A., Riaz, H., Ahmed, M., & Saeed, A. (2022). Does green finance really deliver what is expected? An empirical perspective. *Borsa Istanbul Review*, 22(3), 586-593. <https://doi.org/10.1016/j.bir.2021.07.006>
- Kocur-Bera, K., & Czyża, S. (2023). Socio-economic vulnerability to climate change in rural areas in the context of green energy development—a study of the Great Masurian Lakes Mesoregion. *International Journal of Environmental Research and Public Health*, 20(3), 2689.
- Kumar, S., Talukder, M. B., Kabir, F., & Kaiser, F. (2023). Challenges and sustainability of green finance in the tourism industry: Evidence from Bangladesh. In Sustainable Investments in Green Finance. In (pp. 97-111): IGI Global. <https://doi.org/10.4018/979-8-3693-1388-6.ch006>.
- Laudari, H. K., Aryal, K., Bhusal, S., & Maraseni, T. (2021). What lessons do the first Nationally Determined Contribution (NDC) formulation process and implementation outcome provide to the enhanced/updated NDC? A reality check from Nepal. *Science of the Total Environment*, 759, 143509. <https://doi.org/10.1016/j.scitotenv.2020.143509>
- Li, Q. (2023). Green financing role on climate change-supportive architectural design development: Directions for green architectural designs. *Environmental Science and Pollution Research*, 30(19), 56984-56997. <https://doi.org/10.1007/s11356-023-26229-5>
- Lin, M., Zeng, H., Zeng, X., Mohsin, M., & Raza, S. M. (2023). Assessing green financing with emission reduction and green economic recovery in emerging economies. *Environmental Science and Pollution Research*, 30(14), 39803-39814. <https://doi.org/10.1007/s11356-022-24566-5>
- Lin, Z., Liao, X., & Jia, H. (2023). Could green finance facilitate low-carbon transformation of power generation? Some evidence from China. *International Journal of Climate Change Strategies and Management*, 15(2), 141-158. <https://doi.org/10.1108/ijccsm-03-2022-0039>
- Lipczynska-Kochany, E. (2018). Effect of climate change on humic substances and associated impacts on the quality of surface water and groundwater: A review. *Science of the Total Environment*, 640, 1548-1565. <https://doi.org/10.1016/j.scitotenv.2018.05.376>
- Liu, A., Imran, M., Nassani, A. A., Binsaeed, R. H., & Zaman, K. (2024). Reducing carbon emissions with Geoscience Solutions: A look at the contributions of nuclear energy, technology, and Green Finance. *Geoscience Frontiers*, 15(4), 101698. <https://doi.org/10.1016/j.gsf.2023.101698>
- Mehboob, M. Y., Ma, B., Mehboob, M. B., & Zhang, Y. (2024). Does green finance reduce environmental degradation? The role of green innovation, environmental tax, and geopolitical risk in China. *Journal of Cleaner Production*, 435, 140353. <https://doi.org/10.1016/j.jclepro.2023.140353>
- Mi, Z., Guan, D., Liu, Z., Liu, J., Vigiúí, V., Fromer, N., & Wang, Y. (2019). Cities: The core of climate change mitigation. *Journal of Cleaner Production*, 207, 582-589. <https://doi.org/10.1016/j.jclepro.2018.10.034>
- Michel, D., Eriksson, M., & Klimes, M. (2021). *Climate change and (in) security in transboundary river basins handbook of security and the environment*: Edward Elgar Publishing. <https://doi.org/10.4337/9781789900668.00012>.
- Mngumi, F., Shaorong, S., Shair, F., & Waqas, M. (2022). Does green finance mitigate the effects of climate variability: Role of renewable energy investment and infrastructure. *Environmental Science and Pollution Research*, 29(39), 59287-59299. <https://doi.org/10.1007/s11356-022-19839-y>

- Mohanty, M. (2012). New renewable energy sources, green energy development and climate change: Implications to Pacific Island countries. *Management of Environmental Quality: An International Journal*, 23(3), 264-274. <https://doi.org/10.1108/14777831211217468>
- Mohsin, M., Dilanchiev, A., & Umair, M. (2023). The impact of green climate fund portfolio structure on green finance: empirical evidence from EU countries. *Ekonomika*, 102(2), 130-144. <https://doi.org/10.15388/ekon.2023.102.2.7>
- Mojid, M. A. (2020). *Climate change-induced challenges to sustainable development in Bangladesh*. Paper presented at the In IOP Conference Series: Earth and Environmental Science (Vol. 423, No. 1, p. 012001). IOP Publishing.
- Murshed, M., & Dao, N. T. T. (2022). Revisiting the CO₂ emission-induced EKC hypothesis in South Asia: The role of export quality improvement. *GeoJournal*, 87(2), 535-563. <https://doi.org/10.1007/s10708-020-10270-9>
- Nawaz, M. A., Seshadri, U., Kumar, P., Aqdas, R., Patwary, A. K., & Riaz, M. (2021). Nexus between green finance and climate change mitigation in N-11 and BRICS countries: Empirical estimation through difference in differences (DID) approach. *Environmental Science and Pollution Research*, 28, 6504-6519. <https://doi.org/10.1007/s11356-020-10920-y>
- Ng, A. W., Nathwani, J., Fu, J., & Zhou, H. (2021). Green financing for global energy sustainability: Prospecting transformational adaptation beyond Industry 4.0. *Sustainability: Science, Practice and Policy*, 17(1), 377-390. <https://doi.org/10.1080/15487733.2021.1999079>
- Ning, Y., Cherian, J., Sial, M. S., Álvarez-Otero, S., Comite, U., & Zia-Ud-Din, M. (2023). Green bond as a new determinant of sustainable green financing, energy efficiency investment, and economic growth: A global perspective. *Environmental Science and Pollution Research*, 30(22), 61324-61339. <https://doi.org/10.1007/s11356-021-18454-7>
- Niwalkar, A., Indorkar, T., Gupta, A., Anshul, A., Bherwani, H., Biniwale, R., & Kumar, R. (2023). Circular economy based approach for green energy transitions and climate change benefits. *Proceedings of the Indian National Science Academy*, 89(1), 37-50. <https://doi.org/10.1007/s43538-022-00137-7>
- Numan, U., Ma, B., Sadiq, M., Bedru, H. D., & Jiang, C. (2023). The role of green finance in mitigating environmental degradation: Empirical evidence and policy implications from complex economies. *Journal of Cleaner Production*, 400, 136693. <https://doi.org/10.1016/j.jclepro.2023.136693>
- Qing, L., Yao, Y., Sinisi, C.-I., Salman, A., Jaradat, M., Spinu, A. E., . . . Shabbir, M. S. (2024). Do trade openness, environmental degradation and oil prices affect green energy consumption? *Energy Strategy Reviews*, 52, 101342. <https://doi.org/10.1016/j.esr.2024.101342>
- Rahman, M. H., & Majumder, S. C. (2021). The impact of electricity production sources and GDP on CO₂ emission in Bangladesh: A short-run dynamic. *Indonesian Journal of Sustainability Accounting and Management*, 5(2), 198-208. <https://doi.org/10.28992/ijSAM.v5i2.345>
- Rahman, M. H., Majumder, S. C., & Debbarman, S. (2020). Examine the role of agriculture to mitigate the Co₂ emission in Bangladesh. *Asian Journal of Agriculture and Rural Development*, 10(1), 392-405. <https://doi.org/10.18488/journal.1005/2020.10.1/1005.1.392.405>
- Rahman, M. H., Ruma, A., Hossain, M. N., Nahrin, R., & Majumder, S. C. (2021). Examine the empirical relationship between energy consumption and industrialization in Bangladesh: Granger causality analysis. *International Journal of Energy Economics and Policy*, 11(3), 121-129. <https://doi.org/10.32479/ijEEP.10843>
- Rahman, M. H., Tanchangya, T., Rahman, J., Aktar, M. A., & Majumder, S. C. (2024). Corporate social responsibility and green financing behavior in Bangladesh: Towards sustainable tourism. *Innovation and Green Development*, 3(3), 100133. <https://doi.org/10.1016/j.igd.2024.100133>
- Rahman, M. H., Voumik, L. C., Akter, S., & Radulescu, M. (2023). New insights from selected South Asian countries on the determinants of GHG emissions. *Energy & Environment*, 0958305X231189180. <https://doi.org/10.1177/0958305X231189180>
- Rahman, M. H., Voumik, L. C., Rahman, M. M., & Majumder, S. C. (2024). Scrutinizing the existence of the environmental Kuznets curve in the context of foreign direct investment, trade, and renewable energy in Bangladesh: Impending from

- ARDL method. *Environment, Development and Sustainability*, 26(5), 12619-12638. <https://doi.org/10.1007/s10668-023-03940-4>
- Raihan, A., Tanchangya, T., Rahman, J., & Ridwan, M. (2024). The influence of agriculture, renewable energy, international trade, and economic growth on India's environmental sustainability. *Journal of Environmental and Energy Economics*, 3(1), 37-53. <https://doi.org/10.3390/su13094753>
- Rashed, M. A., Alam, M. M., & Fahim, F. (2014). The performance and challenges of public-private partnership (PPP) projects in Bangladesh. *Journal of Bangladesh Studies*, 15(2), 62-71.
- Rizwanullah, M., Shi, J., Nasrullah, M., & Zhou, X. (2024). The influence of environmental diplomacy, economic determinants and renewable energy consumption on environmental degradation: Empirical evidence of G20 countries. *Plos One*, 19(3), e0300921. <https://doi.org/10.1371/journal.pone.0300921>
- Sadiq, M., Amayri, M. A., Paramaiah, C., Mai, N. H., Ngo, T. Q., & Phan, T. T. H. (2022). How green finance and financial development promote green economic growth: Deployment of clean energy sources in South Asia. *Environmental Science and Pollution Research*, 29(43), 65521-65534. <https://doi.org/10.1007/s11356-022-19947-9>
- Sadiq, M., Nonthapot, S., Mohamad, S., Chee Keong, O., Ehsanullah, S., & Iqbal, N. (2022). Does green finance matter for sustainable entrepreneurship and environmental corporate social responsibility during COVID-19? *China Finance Review International*, 12(2), 317-333. <https://doi.org/10.1108/cfri-02-2021-0038>
- Sarker, S. A., Wang, S., Adnan, K. M., Anser, M. K., Ayoub, Z., Ho, T. H., . . . Hoque, M. M. (2020). Economic viability and socio-environmental impacts of solar home systems for off-grid rural electrification in Bangladesh. *Energies*, 13(3), 679. <https://doi.org/10.3390/en13030679>
- Schuurmans, C. J. E. (2021). The world heat budget: expected changes. In *Climate Change Impact on Coastal Habitation*. In (pp. 1-15): CRC Press. <https://doi.org/10.1201/9781003069935-1>.
- Semmler, W., Braga, J. P., Lichtenberger, A., Toure, M., & Hayde, E. (2021). *Fiscal policies for a low-carbon economy*. Retrieved from World Bank Publications - Reports No. 35795, The World Bank Group:
- Shah, S. B., Jirakiattikul, S., Techato, K., & Mudbhari, B. K. (2023). A systematic review on nexus between green finance and climate change: Evidence from China and India. *International Journal of Energy Economics and Policy*, 13(4), 599-613. <https://doi.org/10.32479/ijeep.14331>
- Shamoon, A., Haleem, A., Bahl, S., Javaid, M., & Garg, S. B. (2022). Role of energy technologies in response to climate change. *Materials Today: Proceedings*, 62, 63-69. <https://doi.org/10.1016/j.matpr.2022.02.025>
- Sharmin, S., Yabar, H., & Richards, D. (2023). Green energy optimization in Dinajpur, Bangladesh: A path to net neutrality. *Sustainability*, 15(2), 1336. <https://doi.org/10.3390/su15021336>
- Smith, C. I., Sweet, L. C., Yoder, J., McKain, M. R., Heyduk, K., & Barrows, C. (2023). Dust storms ahead: Climate change, green energy development and endangered species in the Mojave Desert. *Biological Conservation*, 277, 109819. <https://doi.org/10.1016/j.biocon.2022.109819>
- Suki, N. M., Suki, N. M., Sharif, A., Afshan, S., & Jermisittiparsert, K. (2022). The role of technology innovation and renewable energy in reducing environmental degradation in Malaysia: A step towards sustainable environment. *Renewable Energy*, 182, 245-253. <https://doi.org/10.1016/j.renene.2021.10.007>
- Sun, G., Li, G., Dilanchiev, A., & Kazimova, A. (2023). Promotion of green financing: Role of renewable energy and energy transition in China. *Renewable Energy*, 210, 769-775. <https://doi.org/10.1016/j.renene.2023.04.044>
- Sun, L., Fang, S., Iqbal, S., & Bilal, A. R. (2022). Financial stability role on climate risks, and climate change mitigation: Implications for green economic recovery. *Environmental Science and Pollution Research*, 29(22), 33063-33074. <https://doi.org/10.1007/s11356-021-17439-w>
- Sun, Y., Bao, Q., & Taghizadeh-Hesary, F. (2023). Green finance, renewable energy development, and climate change: Evidence from regions of China. *Humanities and Social Sciences Communications*, 10(1), 1-8. <https://doi.org/10.1057/s41599-023-01595-0>

- Taghizadeh-Hesary, F., & Yoshino, N. (2020). Sustainable solutions for green financing and investment in renewable energy projects. *Energies*, 13(4), 788. <https://doi.org/10.3390/en13040788>
- Tai, A. P., Martin, M. V., & Heald, C. L. (2014). Threat to future global food security from climate change and ozone air pollution. *Nature Climate Change*, 4(9), 817-821. <https://doi.org/10.1038/nclimate2317>
- Tan, R., Aviso, K. B., & Ng, D. (2019). Optimization models for financing innovations in green energy technologies. *Renewable and Sustainable Energy Reviews*, 113, 109258. <https://doi.org/10.1016/j.rser.2019.109258>
- Tariq, G., Sun, H., Ali, I., Pasha, A. A., Khan, M. S., Rahman, M. M., . . . Shah, Q. (2022). Influence of green technology, green energy consumption, energy efficiency, trade, economic development and FDI on climate change in South Asia. *Scientific Reports*, 12(1), 16376. <https://doi.org/10.1038/s41598-022-20432-z>
- The Business Standard. (2023). *At 6.2°C, Tetulia records lowest temperature in Bangladesh in 24hrs*. Retrieved from <https://www.tbsnews.net/bangladesh/62degc-tetulia-records-lowest-temperature-bangladesh-24hrs-569890>
- The Daily Star. (2022). *South Asian nations need a collective plan to tackle climate change*. *The Daily Star*. Retrieved from <https://www.thedailystar.net/opinion/macro-mirror/news/south-asian-nations-need-collective-plan-tackle-climate-change-3122356>
- The Daily Star. (2023a). *Labour force survey: 2022 Agriculture still main job creator*. Retrieved from <https://www.thedailystar.net/news/bangladesh/news/labour-force-survey-2022-agriculture-still-main-job-generator-3283936>
- The Daily Star. (2023b). *Unlocking Bangladesh's renewable energy potential*. Retrieved from <https://www.thedailystar.net/opinion/views/news/unlocking-bangladeshs-renewable-energy-potential-3367231#:~:text=Bangladesh%20faces%20multifaceted%20challenges%20towards,clean%20energy%20sources%20by%202041>
- The Dhaka Tribune. (2023). *Is Bangladesh ready for green investments? - Dhaka Tribune* Retrieved from <https://www.dhakatribune.com/amp/opinion/op-ed/321999/is-bangladesh-ready-for-green-investments>
- Trivedi, J., Chakraborty, D., & Nobanee, H. (2023). Modelling the growth dynamics of sustainable renewable energy—Flourishing green financing. *Energy Policy*, 183, 113846. <https://doi.org/10.1016/j.enpol.2023.113846>
- Uddin, A. (2006). *Bangladesh climate change impacts and vulnerability a synthesis comprehensive disaster management programme government of the people's Republic of Bangladesh*. Retrieved from https://www.preventionweb.net/files/574_10370.pdf
- Uddin, K. M. K., Rahman, M. M., & Saha, S. (2023). The impact of green tax and energy efficiency on sustainability: Evidence from Bangladesh. *Energy Reports*, 10, 2306-2318. <https://doi.org/10.1016/j.egy.2023.09.050>
- UNEP. (2017). *Helping countries tackle climate change*. [online] *UNEP - UN environment programme*. Retrieved from <https://www.unep.org/regions/asia-and-pacific/regional-initiatives/helping-countries-tackle-climate-change>
- UNEP. (2024a). *Green financing*. *UNEP - UN environment programme*. Retrieved from <https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/green-financing>
- UNEP. (2024b). *Helping countries tackle climate change | Asia and the Pacific | UNEP - UN environment programme*. Retrieved from <https://www.unep.org/regions/asia-and-pacific/regional-initiatives/helping-countries-tackle-climate-change>
- UNFCCC. (2016). *The Paris agreement*. *United Nations framework convention on climate change*. Retrieved from <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
- UNFCCC. (2023). *About the secretariat | UNFCCC*. *unfccc.int*. Retrieved from <https://unfccc.int/about-us/about-the-secretariat>
- VijayaVenkataRaman, S., Iniyan, S., & Goic, R. (2012). A review of climate change, mitigation and adaptation. *Renewable and Sustainable Energy Reviews*, 16(1), 878-897.
- Voumik, L. C., Rahman, M. H., Nafi, S. M., Hossain, M. A., Ridzuan, A. R., & Mohamed Yusoff, N. Y. (2023). Modelling sustainable non-renewable and renewable energy based on the EKC hypothesis for Africa's ten most popular tourist destinations. *Sustainability*, 15(5), 4029. <https://doi.org/10.3390/su15054029>
- Voumik, L. C., Rahman, M. H., Rahman, M. M., Ridwan, M., Akter, S., & Raihan, A. (2023). Toward a sustainable future: Examining the interconnectedness among Foreign Direct Investment (FDI), urbanization, trade openness, economic

- growth, and energy usage in Australia. *Regional Sustainability*, 4(4), 405-415. <https://doi.org/10.1016/j.regsus.2023.11.003>
- Wang, Z., Shahid, M. S., Binh An, N., Shahzad, M., & Abdul-Samad, Z. (2022). Does green finance facilitate firms in achieving corporate social responsibility goals? *Economic Research-Ekonomska Istraživanja*, 35(1), 5400-5419. <https://doi.org/10.1080/1331677x.2022.2027259>
- Washim, A. M., Arefin, A. M., & Nusrat, A. (2022). Prospect of green power generation as a solution to energy crisis in Bangladesh. *Energy Systems*, 13(3), 749-787. <https://doi.org/10.1007/s12667-020-00421-9>
- Woo, T. H. (2018). Complex analysis for the climate change impact on the nuclear industry incorporated with the green energy. *International Journal of Global Warming*, 15(1), 98-108. <https://doi.org/10.1504/ijgw.2018.10013182>
- World Bank. (2019). *Climate change. World Bank*. Retrieved from <https://www.worldbank.org/en/topic/climatechange>
- Wu, X., Sadiq, M., Chien, F., Ngo, Q.-T., Nguyen, A.-T., & Trinh, T.-T. (2021). Testing role of green financing on climate change mitigation: Evidences from G7 and E7 countries. *Environmental Science and Pollution Research*, 28, 66736-66750. <https://doi.org/10.1007/s11356-024-34268-9>
- Yadav, M. K., Singh, R., Singh, K., Mall, R., Patel, C., Yadav, S., & Singh, M. (2015). Assessment of climate change impact on productivity of different cereal crops in Varanasi, India. *Journal of Agrometeorology*, 17(2), 179-184. <https://doi.org/10.54386/jam.v17i2.1000>
- Yaghoubi, J., Yazdanpanah, M., & Komendantova, N. (2019). Iranian agriculture advisors' perception and intention toward biofuel: Green way toward energy security, rural development and climate change mitigation. *Renewable Energy*, 130, 452-459. <https://doi.org/10.1016/j.renene.2018.06.081>
- Yu, M., Zhou, Q., Cheok, M. Y., Kubiczek, J., & Iqbal, N. (2022). Does green finance improve energy efficiency? New evidence from developing and developed economies. *Economic Change and Restructuring*, 55(1), 485-509. <https://doi.org/10.1007/s10644-021-09355-3>
- Yue, X.-L., & Gao, Q.-X. (2018). Contributions of natural systems and human activity to greenhouse gas emissions. *Advances in Climate Change Research*, 9(4), 243-252.
- Zandi, G., & Haseeb, M. (2019). The importance of green energy consumption and agriculture in reducing environmental degradation: Evidence from Sub-Saharan African countries. *International Journal of Financial Research*, 10(5), 215-227. <https://doi.org/10.5430/ijfr.v10n5p215>
- Zeb, R., Salar, L., Awan, U., Zaman, K., & Shahbaz, M. (2014). Causal links between renewable energy, environmental degradation and economic growth in selected SAARC countries: Progress towards green economy. *Renewable Energy*, 71, 123-132. <https://doi.org/10.1016/j.renene.2014.05.012>
- Zhang, K., Chen, H., Tang, L., & Qiao, S. (2022). Green finance, innovation and the energy-environment-climate nexus. *Frontiers in Environmental Science*, 10(879681), 10.3389. <https://doi.org/10.3389/fenvs.2022.879681>
- Zheng, G.-W., Siddik, A. B., Masukujjaman, M., & Fatema, N. (2021). Factors affecting the sustainability performance of financial institutions in Bangladesh: The role of green finance. *Sustainability*, 13(18), 10165. <https://doi.org/10.3390/su131810165>
- Zheng, G.-W., Siddik, A. B., Masukujjaman, M., Fatema, N., & Alam, S. S. (2021). Green finance development in Bangladesh: The role of private commercial banks (PCBs). *Sustainability*, 13(2), 795. <https://doi.org/10.3390/su13020795>
- Zheng, M., Feng, G.-F., & Chang, C.-P. (2023). Is green finance capable of promoting renewable energy technology? Empirical investigation for 64 economies worldwide. *Oeconomia Copernicana*, 14(2), 483-510. <https://doi.org/10.24136/oc.2023.013>
- Zhou, X., Tang, X., & Zhang, R. (2020). Impact of green finance on economic development and environmental quality: A study based on provincial panel data from China. *Environmental Science and Pollution Research*, 27, 19915-19932. <https://doi.org/10.1007/s11356-020-08383-2>

APPENDIX

Table 1A. List of abbreviations.

ADB= Asian development bank
BCCSAP - Bangladesh climate change strategy and action plan
BCCTF - Bangladesh climate change trust fund
CIFs - Climate investment funds
CO ₂ - Carbon dioxide
COP - Conference of the parties
EEF - Energy efficiency fund
GE - Green energy
GF - Green finance
GCF - Green climate fund
GHGs - Greenhouse gases
ICMA - International capital market association
IMF - International monetary fund
IRENA - International renewable energy agency
NDCs - Nationally determined contributions
NAPs - National adaptation plans
OECD - Organisation for economic co-operation and development
PV - Photovoltaic
SREP - Scaling up renewable energy program
TW - Terawatt
UNEP - United nations environment programme
UNFCCC - United Nations framework convention on climate change
WB - World bank
BB= Bangladesh bank
UNDP= United nations development programme
UNWTO= World tourism organisation
WCU=World conservation union
WTTC= World travel & tourism council

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