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Bangladesh green industries diagnostic

This study employs the “Bangladesh Green Industries Diagnostic” tool to investigate the root causes of the country’s underperformance in promoting inclusive green growth.

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Bangladesh Green Industries Diagnostic

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Acronyms and Abbreviations

AEEI	Autonomous Energy Efficiency Improvement
BAU	Business as Usual
CCS	Carbon Capture and Storage
CNG	Compressed Natural Gas
CES	Constant elasticity of substitution
COP	Conference of Parties
CSOs	Civil Society Organizations
EIS	Energy Intensive Manufacturing Sectors
ETP	Effluent Treatment Plant
GDP	Gross Domestic Products
GG	Green Growth
GGD	Green Growth Diagnostic
GHG	Greenhouse Gas
INDCs	Intended Nationally Determined Contributions
LULUCF	Land Use, Land-Use Change, and Forestry
TFP	Total Factor Productivity
SSGD/SSD	Steady State Green Growth
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank

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Executive summary

Emerging from independence 52 years ago to become a highly productive industrial and economic force in South Asia, Bangladesh is a success story among developing nations. However, despite Bangladesh's remarkable growth, the country faces significant challenges in achieving sustainable and green growth pathways. As the economy progresses, Bangladesh faces deteriorating green growth social indicators and declining levels of public satisfaction with the status quo. Efforts to boost the economy through fiscal policy and address social exclusion through social grants have yielded positive results in terms of economic development. However, these initiatives have not been successful in achieving their objectives for promoting green growth and sustainable pathways and progress towards environmental sustainability has been slow, with Bangladesh ranking 162nd out of 180 countries in the 2022 Environmental Performance Index. As the economy strives for higher growth, there is an urgent need to address the deteriorating state of green growth indicators.

Bangladesh's per capita CO_2 emissions have increased by over 60% since 2000 (World Bank, 2022). Unfortunately, there has been limited advancement in creating sustainable routes, as policymakers have instead put the country's green investment rating at risk and raised the expense of green capital for the entire economy. While policies aimed at economic development and social grants have yielded positive results, they have fallen short in achieving the desired objectives of empowerment, inclusivity, and sustainable transformation. Bangladesh's remarkable productive capabilities, driven by its people, companies, assets, and knowhow, remain underutilized in the pursuit of green growth. The informal sector, which employs around 88% of the labor force (ILO, 2022), often operates without adequate environmental regulations or enforcement. After 52 year since gaining independence, current strategies are not achieving inclusion and empowerment when promoting green growth and sustainable pathways in practice. This study asks the question of why.

This study highlights the necessity for implementing additional strategies and tools, despite previous research efforts by international organizations. Even if Bangladesh succeeds in economic growth, its impact on mitigating climate change would be minimal without a concerted effort to decarbonize and transition towards green industries. The country's current share of renewable energy in the total energy mix is only around 3% (National Database of Renewable Energy, 2023).

This diagnostic study employs the "Bangladesh Green Industries Diagnostic" tool to investigate the root causes of the country's underperformance in promoting inclusive green growth. The findings reveal two broad classes of problems: 1) failing state capacity and spatial exclusion, and 2) a historical lack of prioritization for reducing emission intensity. Even if we were to succeed in economic growth, our impact on the climate would be minuscule. The question is not what we can do to reduce our country's intensity but how we can supercharge our country's development by breaking into fast-growing industries that will help the world reduce its intensity and reach net-zero by 2050. The dynamic environmental computable general equilibrium (CGE) analysis conducted in this study assesses the impact of formal and informal production units on emissions from 2025 to 2050, providing policymakers with evidence-based information on the potential outcomes and trade-offs associated with different green policies and practices.

Bangladesh is compelling to study due to its high population density and growing instances of environmental pollution, such as metalloid exposure and heavy metal poisoning, which pose significant risks to public health and ecosystems. Secondly, Bangladesh's rapid industrialization has been characterized by the unregulated establishment of industrial facilities. This study aims to investigate sustainable solutions to address these issues while promoting green growth and sustainable development. Bangladesh allows for the unregulated establishment of industrial facilities during its development, which are predominantly operated informally and employ 80% of the workforce, while contributing 30% to the country's GDP. These small to medium-sized enterprises are typically situated in the outskirts of the capital and other major cities, leading to unplanned urbanization and environmental issues in urban areas. Besides, environmental regulations are routinely violated in Bangladesh due to a lack of enforcement by the relevant agencies, whom appear to be corrupt, ineffective, and weak. This enables an undue opportunity to businesses to cause serious pollution through their uncontrolled waste disposal. The informal producing sector accounts for two-thirds of the total informal contribution to Bangladesh's GDP. Thus a 'Green Industries Diagnostic' needs to be initiated to achieve the sustainability prospects of urban development. Overlooking the existence of the informal sector in the formulation and implementation measures of environmental policy may lead to misleading outcomes.

This study emphasizes the importance of identifying obstacles to green growth and promoting sustainable economic pathways and discusses the challenges faced by Bangladesh in achieving green growth and sustainable pathways, including declining social indicators, increasing exclusion and slow creation of green jobs. It highlights the underutilization of the country's capabilities in achieving sustainable growth and the need for new strategies and instruments to promote inclusive growth and address spatial exclusion. The report also outlines the potential opportunities for Bangladesh in the decarbonization process and the importance of considering the informal sector in environmental policy. This study has several important findings.

Firstly, it uses dynamic environmental CGE analysis to assess the impact of formal and informal production units on emission from 2020-2050. This analysis provides policymakers with evidence-based information on the potential outcomes and trade-offs associated with different green policies and practices. This can guide the formulation of targeted policies and incentives to promote sustainable and low-carbon pathways. Secondly, the study uses dynamic analysis to conduct a green industry diagnostic in Bangladesh. This diagnostic helps align industrial policies and practices with environmental and climate commitments, promote economic growth, and enhance resilience to climate change up to 2050. This provides a roadmap for sustainable development in the country. Lastly, this study estimates the job creation potential of these production units from 2025-2050.

Based on these findings, the project proposes several key recommendations, including pinpointing areas requiring immediate attention, tailoring energy policies to Bangladesh's needs, boosting renewable energy investments, enforcing emission standards, providing green investment incentives, encouraging public-private partnerships, and enhancing government capacity for effective implementation and monitoring of environmental regulations. The project has several key recommendations:

- Pinpoint key areas that require immediate attention or intervention by considering backward and forward linkages,
- Tailor energy sector policies to Bangladesh's specific needs, focusing on technological innovation and renewable energy integration,
- Boost investments in solar, wind, and hydro power to reduce reliance on fossil fuels and support sustainable growth,
- Enforce strict emission standards, diligent monitoring, and offer renewable energy incentives to significantly reduce carbon emissions,
- Collaborate with financial institutions to provide green investment incentives, including low-interest loans and green bonds,
- Encourage partnerships between government and private sectors to adopt green technologies and sustainable development projects, and
- Enhance the ability of government agencies to implement and enforce environmental regulations effectively and transparently.

SECTION 1. GREEN INDUSTRIES DIAGNOSTIC-AN OVERVIEW

1.1 Background of Green Industries Diagnostic

The Green Industries Diagnostic (GID) is a tool designed to assess and analyze the maturity and performance of green industries within a particular region or country (Belik et al., 2018). It provides valuable insights into the current status, challenges, and opportunities for green industry development, enabling policymakers and stakeholders to make informed decisions and strategies for low carbon development (Mehmood et al., 2024). The diagnostic involves a comprehensive assessment of various sectors, including renewable energy, waste management, sustainable agriculture, green building, and eco-tourism. It evaluates factors such as policy and regulatory frameworks, market conditions, technology adoption, skills and capacity building, investment opportunities, and environmental impact (Appolloni et al., 2022). This diagnostic process is essential for promoting low carbon pathways as it allows countries to understand their current industrial landscape and identify areas where there is potential for sustainable development (Lee & Woo, 2020). By identifying industry-specific challenges and opportunities, policymakers can tailor their strategies to promote the growth of green industries that align with low carbon goals (Salles et al., 2022).

For example, if the diagnostic reveals a lack of policy support or regulatory barriers for renewable energy development, policymakers can focus on implementing supportive policies and streamlining regulations to attract investment and promote the deployment of clean energy technologies (Liu et al., 2020). Similarly, if the diagnostic highlights a lack of skills or capacity in the green building sector, policymakers can prioritize training programs and partnerships with educational institutions to build the necessary workforce (Li et al., 2020). Thus, the diagnostic process also helps in identifying market opportunities and the potential for job creation. By analyzing market conditions and conducting market studies, countries can identify sectors with high potential for growth and job creation, such as sustainable agriculture or eco-tourism (Wartini et al., 2022). This information can guide policymakers in allocating resources and designing targeted programs to enhance market competitiveness and promote green job creation. Thus, many countries all over the world are working on green industries diagnostic to assess and analyze the maturity and performance of green industries in recent years (S. Chen & Golley, 2014).

The lack of studies on green industries diagnostic in Bangladesh is a significant gap that needs to be addressed (M. M. Rahman & Kashem, 2017). Conducting green industries diagnostic in Bangladesh would be valuable for several reasons. Firstly, Bangladesh is a developing country with a rapidly growing industrial sector. As the country seeks to achieve its development goals, it is crucial to ensure that this growth is sustainable and in line with national and international environmental commitments (M. M. Rahman, 2021). A green industry diagnostic would provide insights into the current state of the industrial sector, its environmental impacts, and opportunities for greening. Secondly, Bangladesh is vulnerable to the impacts of climate change, including rising sea levels, increased frequency and intensity of extreme weather events, and effects on ecology and changes in rainfall patterns. The industrial sector, if not properly managed, can contribute to these climate risks. By conducting green industries diagnostic, Bangladesh can identify strategies to reduce greenhouse gas emissions and adapt to the impacts of climate change. Thirdly, a green industry diagnostic can help identify opportunities for economic growth and job creation in Bangladesh. The transition to a greener and more sustainable industrial sector can stimulate innovation, create new markets, and attract investments (Karim et al., 2019).

To enhance the growth and sustainability of green industries in Bangladesh, a thorough and comprehensive green industry diagnostic approach is required. This involves gathering detailed data on energy consumption, emissions, and resource utilization across various sectors, coupled with engaging diverse stakeholders—ranging from industry representatives to local communities—in consultations to ensure broad support for future initiatives. By pinpointing the distinct challenges and opportunities present within sectors like textiles and garments, and renewable energy, Bangladesh can tailor policies and incentives that encourage the development of environmentally friendly businesses while leveraging their potential for economic benefit. Such a diagnostic is crucial for a holistic strategy aimed at fostering sustainable industrial growth (G. C. Chen, 2023).

1.2 Target of Green Industry Diagnostics

Countries that prioritize green growth often experience higher levels of economic growth compared to those that solely focus on traditional forms of development. This is because green growth strategies promote the efficient use of resources, leading to cost savings and increased productivity. Additionally, green growth can contribute to poverty reduction by creating new job opportunities and improving livelihoods, particularly for those dependent on natural resources (Castor et al., 2020). For example, investing in renewable energy projects can create employment in the clean energy sector, while also reducing harmful greenhouse gas emissions and improving air quality. Green growth is also closely linked to resilience to climate change. By implementing sustainable practices and infrastructure, such as climate-resilient agriculture, renewable energy systems, and effective disaster risk management, countries can reduce their vulnerability to environmental shocks and improve their capacity to recover from climate change (Corfee-Morlot et al., 2012). Furthermore, pursuing green growth can enhance energy security by diversifying the energy mix and reducing dependence on fossil fuels (Fuentes et al., 2020). This can lead to greater energy independence, reduced price volatility, and increased access to clean and affordable energy sources.

1.3 Green Industry Diagnostics Approach

The use of a model in the green industries diagnostic analysis for a country enables the assessment of the economic and environmental impacts of different policy measures. The model considers the carbon intensity of production, sectoral production and wage, and GDP growth rate, among other factors, to project the effects of transitioning towards a greener development pathway. The model takes into account different goods and sectors within the economy, providing a comprehensive analysis of the potential impacts. This single-country modelling approach allows for a detailed understanding of the specific conditions and dynamics of an economy. By simulating various scenarios, policymakers can gain insights into the potential outcomes of different policy choices. The outcomes can help guide the formulation of effective policies that align industrial development with environmental goals (Y. Chen et al., 2024).

A number of recent studies on green industry diagnostics focused on data collection, stakeholder consultations, benchmarking, and providing recommendations (Shao et al., 2022; Sun & Zeng, 2023). However, each study contained its own specific procedures, nuances, and regional or sectoral focus. For example, some studies may have a stronger emphasis on specific sectors such as renewable energy or waste management, while others may take a more holistic approach, considering multiple sectors and their interlinkages. Some studies may also include a more detailed analysis of policy frameworks, market dynamics, and investment opportunities, while others may prioritize technical assessments or environmental impact assessments (Castor et al., 2020; Khan et al., 2021). Moreover, the scope and depth of stakeholder consultations may vary among studies (Sarkar, 2013). Some studies may engage a wider range of stakeholders, including industry associations, civil society organizations, and local communities, to capture a more comprehensive range of perspectives and ensure buy-in from different actors (Caena, 2014). Other studies may focus primarily on government officials and technical experts.

Overall, while there may be variations in methodologies, scopes, and focuses among different studies on green industry diagnostics, they all share a common objective of assessing the current state of the industrial sector and providing recommendations for promoting sustainable and low carbon development (Belik et al., 2018). However, dynamic technique-based modeling on green industries diagnostic plays a crucial role in promoting low carbon pathways by providing countries with a comprehensive understanding of their existing industries and their potential for sustainable development. By identifying challenges and opportunities, policymakers can design effective policies, attract investments, build capacity, and promote the growth of green industries, ultimately accelerating the transition towards a low carbon economy (Figure 1). The diagnostic process begins with data collection and analysis to understand the current state of the industrial sector in terms of its carbon intensity and sustainability practices. This includes gathering information on energy consumption, emissions, and efficiency in different industries. The data is then analyzed to identify key areas of improvement and determine the baseline for benchmarking against international best practices.

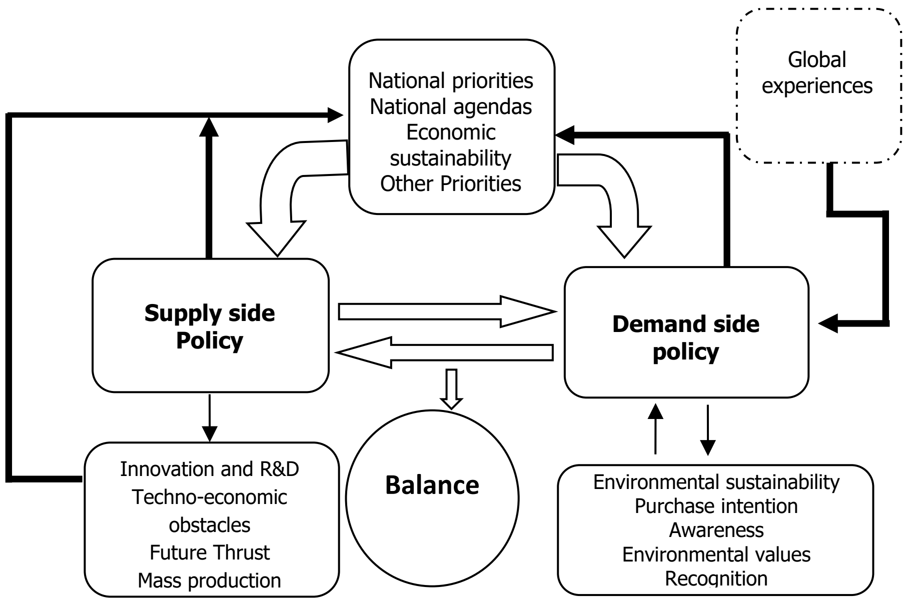

Figure 1: Green economy: demand side and supply side policy coordination
Source: Al-Amin & Doberstein (2019)

1.4 Encouraging Green Growth: International Experiences

The concept of green growth is gaining importance in the quest for economic development with the help of environment friendly sustainable measures in many nations (World Bank, 2012). For example, India is taking a different approach by emphasizing the developing economy and green growth using expanding renewable energies, energy efficiency drives and sustainable agriculture (Dutz & Sharma, 2012). India's has made ambitious targets in renewable energy specifically in solar and wind energy which is seen as an important development in the Governments National Action Plan for Climate Change. India Government has also released a scheme that incentivizes State-owned thermal power plants of the National Thermal Power Plant (NTPC) to improve their energy efficiency. China has set green development as a priority under its 13th Five Year Plan with the aims of reducing carbon intensity and increasing the proportion of non-fossil fuels in its energy mix towards green growth

(Hepburn et al., 2021). As a result, China has emerged as the world leader in renewable energy investment and production, particularly through renewables like solar photovoltaic (PV) panels and wind turbines, helping drive the global green technology market (Jackson et al., 2021). Thailand's AEDP is governed by a series of five-year strategic plans for green growth that will provide the framework for new investments, some under private partnerships and government incentives (Anbumozhi & Tuan, 2017). Thailand has introduced eco-industry park initiatives to promote cleaner production processes, green growth and sustainable industrial development (Bunjongsiri et al., 2015).

To promote green growth, the government has launched the Eleventh Malaysia Plan and Green Technology Master Plan, Malaysia focusses on sectors such as renewable energy, energy efficiency, green transportation and sustainable waste management in mitigating climate change (Isa et al., 2021). The government would like to give emphasis towards balancing issues relating to socio-economic development in line with the global environmental needs, targeting a decrease in the 2030 greenhouse gas emissions intensity of GDP in percentage (Raihan et al., 2022). The experience of these countries provides very valuable lessons for Bangladesh to implement its green industries diagnostic and its green growth trajectory. The visual representation in Figure 2 illustrates the variations in emissions associated with value added in India, Pakistan, Bangladesh, Vietnam, and Bhutan between the years 2014 and 2016. The international experiences of advanced developing countries within Asia like China, Malaysia, and Thailand as well as our neighboring countries such as India, Pakistan, Vietnam and Bhutan would help Bangladesh on encouraging green growth development and friendly sustainable measures.

1.5 Explanation of Low Carbon Development and Green Industry Diagnostics

Low carbon development refers to the transition towards an economic and social development path that minimizes greenhouse gas intensities and mitigates the impacts of climate change (Tan et al., 2017). It focuses on decoupling economic growth from carbon-intensive activities and promoting sustainable, low-carbon practices across sectors. Low carbon development encompasses a wide range of strategies, including energy efficiency, renewable energy deployment, sustainable transportation, waste management, and land-use planning (Nakata et al., 2011). It aims to reduce dependency on fossil fuels, increase resource efficiency, and promote the use of cleaner and greener technologies. Green industry diagnostics is a process dedicated to evaluating the industrial sector's environmental state within a particular country or region, aiming to pinpoint obstacles and drivers for adopting green practices and technologies across industries. This approach, grounded in comprehensive analyses of factors like policy frameworks, market dynamics, technology and innovation landscapes, as well as stakeholder engagement, seeks to enhance carbon emission reduction, resource efficiency, and the integration of circular economy principles.

From figure 2, we can observe a significant increase in value-added (output) from $168,270 million in 2014 to $213,910 million in 2016, reflecting a growth rate of approximately 27% over the two-year period in Bangladesh. Exports also increased from $27,348 million to $30,524 million, albeit at a slower rate of around 11%. Regarding emissions, the data shows an increase across all three estimates, indicating an increase of around 14% and 18%, respectively, between 2014 and 2016. Bangladesh and Cambodia experienced the highest value-added (output) growth rates, at 27% and 19%, respectively, between 2014 and 2016. Vietnam and Pakistan also witnessed strong export growth, at 21% and 17%, respectively, during the same period.

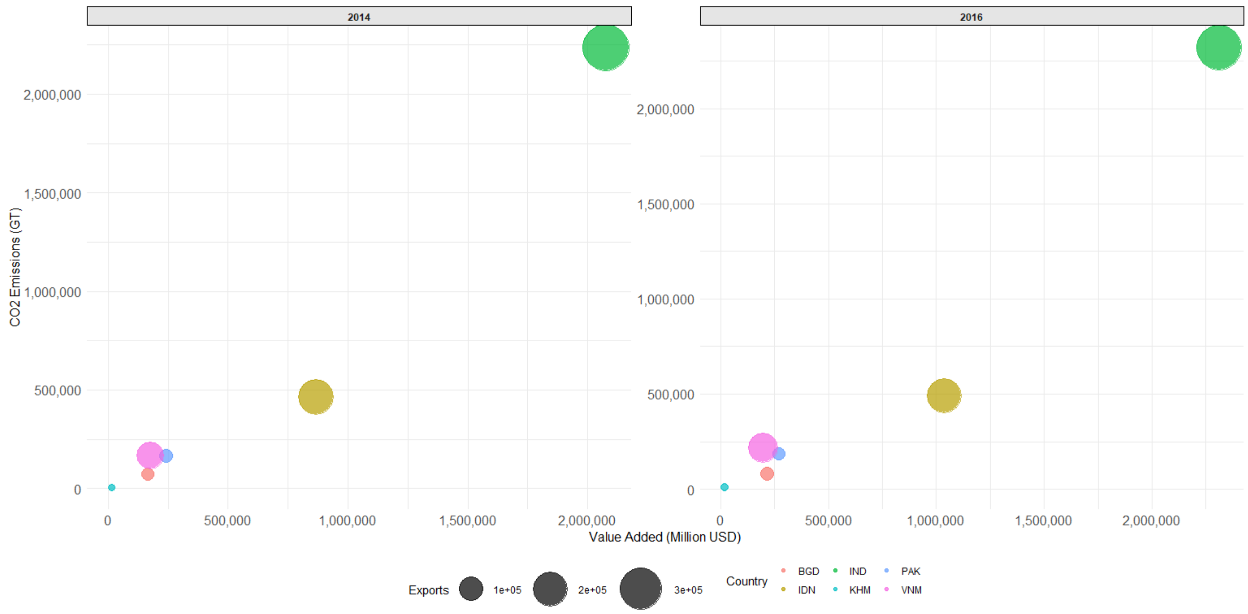

Figure 2. Value Added vs. CO2 Emissions by Country and Year
Source: CO2 data source: CDIAC (2024)

1.5.1 Why green industries diagnostic is important for low carbon pathways?

The importance of green industries diagnostic for advancing low carbon pathways is multifaceted, offering a comprehensive evaluation of the current state, challenges, and opportunities within sustainable sectors (Molla et al., 2024). This diagnostic is pivotal in assessing industries' alignment with low carbon goals, enabling the identification of barriers and enablers to green growth (Berg et al., 2021). By pinpointing these critical factors, it informs the creation of targeted policies, strategic interventions, and regulatory reforms aimed at overcoming obstacles and leveraging potential for emission reduction and resource efficiency. Moreover, the diagnostic process aids in recognizing investment opportunities and areas ripe for technological innovation and adoption, thus facilitating a transition towards a greener economy (Bressanelli et al., 2022). Green industry diagnostics serve as a cornerstone in strategizing for low carbon economies by offering evidence-based insights that support policymaking and capacity building (Wang et al., 2024). The process engages a broad spectrum of stakeholders, fostering a comprehensive understanding of green industry challenges and prospects. It highlights the necessity for technology transfer, innovation, and enhancing industry-specific skills to navigate the shift towards sustainable practices effectively. This diagnostic approach is instrumental in steering countries towards achieving their low carbon objectives, ensuring that development is both sustainable and inclusive.

1.5.2 Green Industries Diagnostic and Perspective in Bangladesh

The green industries diagnostic emerges as a pivotal tool for nations like Bangladesh, keen on navigating the path to sustainable development while embracing a low carbon economy framework. In recent years, Bangladesh has witnessed remarkable progress in its value-added and export sectors. The country has diversified its economy, moving beyond traditional sectors such as agriculture and textiles to embrace industries like pharmaceuticals, information technology (IT), and ready-made garments (RMG). The RMG sector, considered the backbone of Bangladesh's economy, has consistently demonstrated substantial value added and export growth (M. T. Rahman et al., 2017). This sector encompasses the manufacturing of clothing and textiles for both domestic and international markets. With competitive labor costs, the RMG industry has attracted a considerable amount of investment, leading to an increase in value-added production and significant export earnings. The IT sector has emerged as one of the fastest-growing industries in Bangladesh. With a skilled young workforce and favorable government policies, the sector has experienced exponential growth in value-added activities as well as exports (McCartney, 2017). IT services, software development, and outsourcing have become key drivers of the economy and have helped position Bangladesh as a global player in the digital services market.

The pharmaceutical sector has also seen remarkable growth in recent years. Value-added activities in this sector include the manufacturing of drugs, medicines, and medical equipment (Islam et al., 2018). With an emphasis on quality and adherence to international standards, Bangladeshi pharmaceutical companies have gained recognition globally, resulting in increased export earnings and value-added production. This sector has not only contributed significantly to the country's economy but also helped improve access to affordable healthcare both domestically and internationally (Chaudhuri, 2020). Apart from these sectors, agriculture, jute, and leather industries also play a significant role in Bangladesh's economy. Although their contribution to value-added production and export earnings may not be as significant as the previously mentioned sectors, they still remain vital for the country's socio-economic development. Overall, the expansion of value-added and export activities across various sectors in Bangladesh reflects the country's commitment to economic diversification and its willingness to explore new opportunities. Figure 3 show the value added and exports by sector in Bangladesh with a comprehensive overview.

However, Bangladesh's particular susceptibility to the impacts of climate change, compounded by its dense population, necessitates a shift towards a green growth model that harmoniously blends environmental sustainability with economic growth and social inclusivity (Raihan, 2023). Such diagnostics are instrumental in dissecting the current landscape of green industry development, pinpointing challenges, and uncovering potential growth avenues. It spans critical sectors including renewable energy, where it gauges the sector's maturity and hurdles to harness solar and wind power more effectively; the textile and garment industry, assessing sustainability practices and recommending enhancements for environmental compliance; and sustainable agriculture, where it evaluates the adoption of eco-friendly farming practices. This comprehensive analysis aids in identifying pivotal intervention areas to bolster renewable energy deployment, ensure sustainable industrial practices, and enhance rural livelihoods through green agriculture. The diagnostic process thus offers a holistic view of the sustainability, efficiency, and environmental impact across varied sectors, setting the stage for Bangladesh to foster sustainable development, stimulate job creation, and pave the way for a resilient green economy.

Visual representation in Figure 3 illustrates the transformations in emissions, value added, and job opportunities in various sectors of Bangladesh from 2014 to 2016. The textiles and wearing apparel sector stand out as a significant contributor to Bangladesh's economy, accounting for 8% of the total value-added and generating over $22 billion in exports in 2014. Despite its sizeable output, this sector has relatively low carbon emissions, making it an attractive sector for sustainable growth. The agriculture, hunting, forestry, and fishing sector is also a major employer, accounting for around 26 million jobs in 2014, while contributing 16% to the country's value-added. The education, health, and other services sector is another significant employer, with over 5 million jobs in 2014, and contributing 17% to the value-added. However, this sector's export potential appears to be limited. The trade, maintenance, and repair sector, although not a major exporter, accounts for a substantial 12% of the value-added and employs nearly 8 million people, highlighting its importance in domestic economic activity.

It's worth noting that some sectors with relatively low contributions to value-added and employment, such as petroleum, chemical, and non-metallic mineral products, as well as electricity, gas, and water supply, have high carbon emissions, indicating potential areas for targeted interventions to promote sustainable growth.

Figure 3. Value-added, carbon emission, employment vs. exports by sector

1.6 Scope of the Report and Green Industries Diagnostic's Outlook in Bangladesh

The green industries diagnostic in Bangladesh encompasses a comprehensive assessment of the country's industrial sectors, including energy, production, agriculture, transportation, construction, and more, to identify potential for sustainable growth and low carbon pathways (Karim et al., 2019)(Raihan, 2023). This diagnostic process involves evaluating policy and regulatory frameworks, market conditions, technological advancements, skills, access to finance, and environmental impacts through data collection, stakeholder consultations, and market analysis. It aims to uncover opportunities and challenges for green industry development, such as policy gaps, regulatory barriers, and lack of finance, which are crucial for formulating targeted strategies to foster the growth of green industries, enhance resource efficiency, and reduce emissions intensity in alignment with Bangladesh's commitment to sustainable development and its Nationally Determined Contributions (NDCs) (Kibria, 2023). Furthermore, the diagnostic highlights the importance of capacity building and technology transfer for advancing green industries by identifying areas in need of knowledge and technology exchange, which could significantly accelerate Bangladesh's transition to a sustainable economy. This approach not only supports the country's climate goals but also promotes job creation and economic resilience, ensuring a holistic advancement towards environmental sustainability and economic growth.

1.7 Assessment Design and Green Growth Pathways

Designing an effective assessment for green growth pathways in Bangladesh requires a multi-faceted approach, considering the current economic status, sectoral developments, technological potentials, and the broader socio-environmental impact of transitioning to a green economy. Identifying sectors critical for energy consumption and greenhouse gas emissions sets the stage for targeted investments and innovations in renewable energy and efficient technologies. By understanding the potential for technological advancements, policymakers can steer the economy towards sectors ripe for green growth, ensuring inclusivity and societal benefits across job creation, poverty reduction, and environmental well-being. Engaging a broad spectrum of stakeholders, including businesses, NGOs, and civil society, ensures that the assessment captures diverse perspectives and addresses the collective needs and priorities. However, obstacles to sustainable growth must be carefully analyzed using diagnostic tools to ensure Bangladesh can meet its development aspirations by 2041 (Al-Amin, 2021). This comprehensive diagnostic approach, including the analysis of sector-specific energy consumption and intensity alongside output and employment trends, aims to identify sectors that are pivotal for sustainable economic growth, thereby aligning policy initiatives with the nation's developmental goals and the ambitious vision for 2041. The goal is to identify sectors that can contribute to sustainable economic growth and outline the planned actions to achieve the overall project goals (Figure 4). The report also details the steps taken to evaluate potential obstacles to green growth, integrate green growth into economic policies, and identify policies that can foster green innovation by: (a) Addressing green growth constraints (with emission intensity), (b) Scope of policies to foster green innovation, (c) Model and scenarios, and (d) Possible policies to foster green innovation.

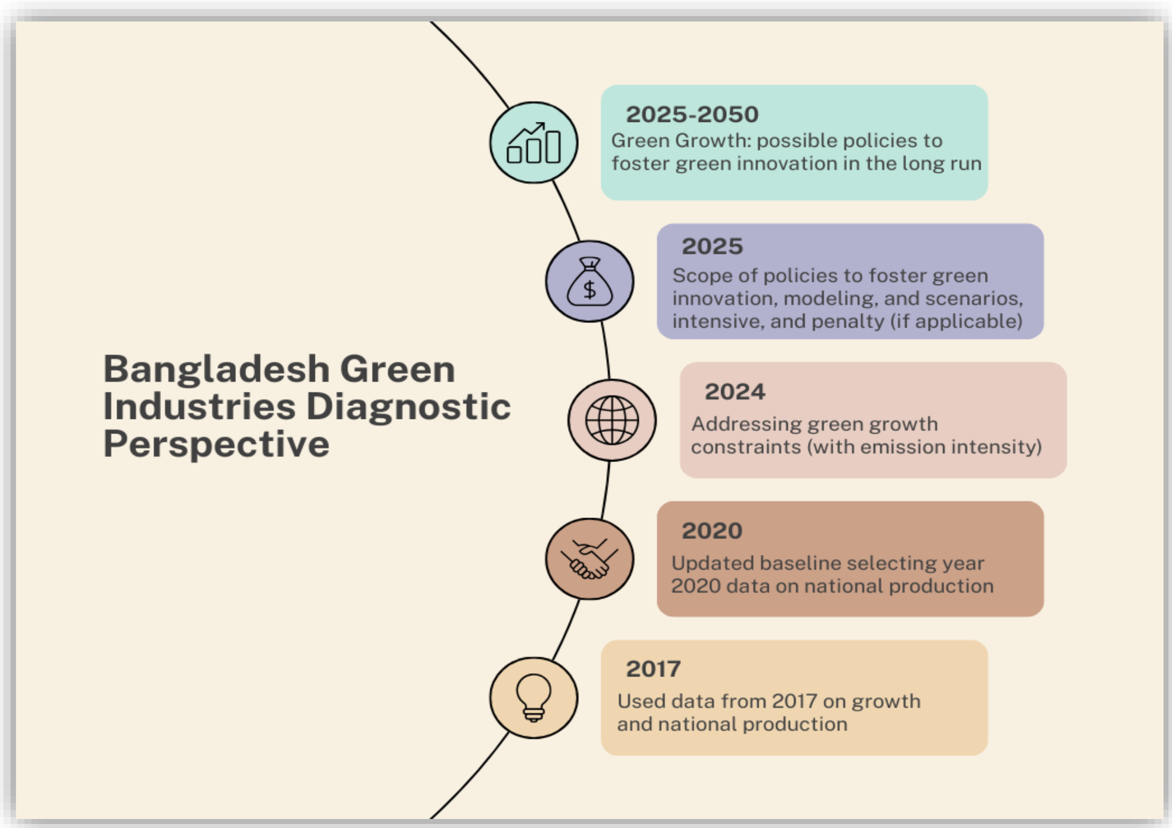

Figure 4. Bangladesh green industries diagnostic perspective

The current work analyses of output, intensity, and employment and that will be more comprehensive, incorporating growth simulations. The report outlines the steps taken during this evaluation process, including addressing constraints related to intensity, integrating green growth into economic policy, and stimulating green innovation through various measures[1]. To attain 'Green Growth', different countries face distinct obstacles that impede the progress of eco-friendly economic expansion (Lyytimäki et al., 2018). These limitations are contingent upon specific environmental challenges, highlighting the need for a customized diagnostic framework for each country. This framework aims to identify the primary barriers to promoting sustainable growth by defining constraints to green growth as factors that limit the advantages of investments and innovations intended to foster economic development, while simultaneously safeguarding natural resources and environmental services that contribute to our overall welfare.

The importance of obstacles to promoting green growth will vary depending on the level of development, social and economic context, and existing policies. Policymakers have a range of policy options at their disposal to address the challenges facing green growth. It is important for them to identify and capitalize on potential synergies by aligning objectives and leveraging ancillary benefits. Moreover, the examination evaluates the relationship between energy consumption, intensity, output, and employment across various sectors. It also investigates the interconnectedness of sectors in terms of their output and intensity. Through the accomplishment of the project's goals, the analysis pinpoints sectors that have the potential to drive sustainable growth. The diagnostic framework derived from the study results provides a foundation for future research on the obstacles faced by these promising sectors. To support the development of 'Green Growth Diagnostic', three major and fundamental activities identified in the study assignment among others indicated earlier:

1. **Impact Analysis and Policy Design** – To support the design and implementation of a 'Green Growth Diagnostic', we require an impact analysis to examine the potential impact of different intensity by sector and impact scenarios on, as well as guidance in establishing key design options and the associated regulatory requirements.
2. **Strategy and Guideline** – The study will be identified the need to improve the understanding of key principles of obstacles to green growth, integrate green growth into economic policies, and identify policies that can foster green innovation among a wide range of stakeholders, including private sector actors in the industry sectors most likely to be subject to policy design.
3. **Policy Recommendations** – Recommend policy measures, capacity-building initiatives, and investment strategies to support the transition towards green industries.

1.8 Structure of the Report

The remainder of the report has several sections. Section two discusses the methodology. The third section presents the results and discussion section. The fourth and fifth sections deal with the policy recommendation and conclusion, respectively.

[1] The report also emphasizes the utilization of a CGE model instead of IO analysis, which is anticipated to offer more comprehensive diagnostics. However, specific details regarding the project's progress, provisional findings, implications, and stakeholder involvement were not provided. Further updates are expected from the IGC.

SECTION 2. METHODOLOGY, METHODS, AND DATA

2.1 Overview of the Method

The green industries diagnostic analysis in Bangladesh utilizes a Computable General Equilibrium (CGE) model to explore the impacts of carbon intensity and future regulations on the economy from 2020 to 2040, incorporating 12 aggregated industrial sectors ranging from agriculture to services by utilizing FY2020 Social Accounting Matrix (SAM) of Bangladesh[2]. This analysis is crucial for formulating effective policies by assessing carbon intensity across sectors, exploring sectoral production and wage impacts, and understanding the effects on GDP growth towards a greener economy. The CGE model, adapted significantly from Takeda (Takeda, 2007) for this specific study, offers a comprehensive view of the supply and demand sides of the economy, accounting for factors like investment behavior, government expenditure funded by various taxes, and international trade. Simulation scenarios, including a business-as-usual baseline and policy reform states, facilitate the assessment of carbon regulation impacts, providing insights into the economic feasibility of green policies. The model's framework encompasses government roles, business operations, and household decisions within a competitive market setup, emphasizing the strategic importance of sector-specific analyses and policy interventions for sustainable development.

2.2 Production Side

The Computable General Equilibrium (CGE) model used in Bangladesh's green industries diagnostic analysis leverages primary factors and intermediate inputs like labor, capital stock, land, and resources to assess the economy's response to changes in carbon intensity and green development policies from 2020 to 2050. Specialized sectors, including agriculture which uniquely utilizes land, and the fossil fuels and electricity sectors that use specific resources, employ a constant elasticity of substitution (CES) production function to reflect technological utilization and sectoral differences. The model, directed by MIT's EPPA model guidelines (Chen et al., 2015), and further detailed by Takeda (2007), is distinguished by its nested CES function, illustrating varying elasticity of substitution values among inputs. This framework helps analyze sector-specific production constraints, such as land for agriculture and resources for fossil fuels and electricity, allowing for a nuanced understanding of each sector's contribution to the economy and its potential for green growth. The electricity sector's unique consideration of energy composite as a nonenergy intermediate input underscores the inelasticity between fossil fuels, energy input, and the capital-labor composite, highlighting sector-specific nuances in green growth strategies.

2.3 Demand Side

The model incorporates a representative household to demonstrate the demand side of the economy, capturing the dynamics between labor supply, leisure, consumption, and saving decisions. The household's utility, as shown by a nested CES function (Bernstein et al., 1999; Babiker et al., 2009), balances expenditures against leisure time, taking into account the trade-offs between earning income through labor and enjoying leisure. The decision on labor supply is influenced by wage rates and the household's preference for leisure over work, impacting the household's income level and consequently, its capacity to save and consume. Savings reflect deferred consumption for future investment or spending, driven by interest rates, preferences, and future financial expectations. The income generated by the household from labor and capital investments, facilitated by payments from

[2] The full SAM, parameters, variables, and other necessary data will be provided upon request and macro-SAM incorporated in the Appendix.

firms for labor and returns on capital, supports its consumption and savings activities, underlining the interconnectedness of household decisions with the broader economic framework.

2.4 The Dynamics of the Model

Our model adopts a dynamic and forward-looking approach, inspired by Takeda's (Takeda, 2007) framework, to evaluate future economic dynamics without considering adjustment costs for investments. Unlike static or recursive dynamic models, our model uniquely captures the intertemporal choices of households and investors, emphasizing the significant role of expected returns on investment decisions. This approach aligns with methods used in prominent climate change policy models like the MIT EPPA model (Chen et al., 2015) and the OECD ENV-Linkages model (Château et al., 2008), enabling a nuanced analysis of how investment choices today are influenced by anticipated future economic conditions. Specifically, the model explores how the corporate tax rate affects investment behavior, illustrating that a lower future corporate tax rate can stimulate current investments. This capability to reflect the economic impact of future-oriented actions offers a comprehensive understanding of potential shifts in resource allocation and investment strategies, providing insights into the economy's long-term trajectory under various policy scenarios.

$$u^L = \left[\sum_{t=t0}^{T} \alpha_t^u (u_t^P)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \text{ (1)}$$

Where, u^Lconsiders as total utility[3], u_t^Pconsiders as period utility with time periods (t) and intertemporal elasticity of substitution (σ), $t0$ considers as first period, and T considers as terminal period knows as ending model timeline.

The study utilizes a deterministic dynamic model that reduces uncertainty in macroeconomic variable forecasts over the long term, focusing on a representative household that acts with full knowledge of the impacts of their choices, reflecting a broader trend of informed decision-making across all model agents. This model, inspired by the works of Babiker et al. (Babiker et al., 2009), is forward-looking, solving for all periods up to 2050 simultaneously and considering forward-looking dynamics to manage the challenge of investment decline towards the model's end. To mitigate rapid investment decreases as the terminal period approaches, a condition ensures the rate of increase in consumption equals the rate of increase in investment in the final period, promoting smooth investment transitions. Furthermore, the model assumes constant contributions from specific sector resources and land over time, with hydropower or nuclear power generation remaining unchanged. This approach accommodates technological advancements affecting carbon intensity efficiency, factoring in the growth rate of total factor productivity (TFP) and improvements in energy efficiency (AEEI) within the "Simulation Scenarios" section, thereby offering a comprehensive and realistic overview of the economy's evolution towards 2050 under varying conditions.

2.5 Government

The government generates revenue through various taxes, including corporate, income, and consumption taxes, which are then used to fund government expenditures. In our study, we assume no significant changes in government spending from the benchmark level in the future. Specifically, our environmental policy reform simulation involves adjusting the rates of income, corporate, and

[3]Commonly, equivalent variants are included in CGE analyses to evaluate welfare implications. The relationship between the change in utility and the change in real income, expressed as a percentage, is as specified in equation (1). (i.e., equivalent variations divided by the benchmark income).

consumption taxes downward as part of a shadow environmental policy reform effort. While other taxes may exist and evolve over time in Bangladesh, our research primarily focuses on these three due to their significant role in the tax system. The income tax applies to household employment earnings, corporate tax to investor earnings, and consumption tax to purchases of goods and services. We calculate benchmark tax rates for these taxes by dividing the total taxes paid by the total amount collected in the base year, utilizing data from the Bangladesh Bureau of Statistics (BBS) and Bangladesh Bank for 2020 and prior years.

2.6 International Trade (Exports-Imports)

In our analysis, we focus solely on Bangladesh, but it is important to consider the impact of international trade on the economy. To incorporate international trade, we adopt the approach used in MIT EPPA model (Y.-H. H. Chen et al., 2015) and assume that Bangladesh is a small country, meaning that trade terms remain unchanged. Additionally, it is presumed that the foreign exchange rate is modified in order to preserve the trade balance at the standard level. In order to represent the exchange of goods, we apply the Armington assumption, which combines imperfect substitutes for domestically produced and imported goods via a CES function (Shen & Zhao, 2022).

2.7 Carbon Intensity

Carbon intensity is introduced to control carbon intensity in scenario simulations. To regulate carbon intensity, a carbon intensity with likely shadow environmental policy reform is utilized[4]. The shadow policy is applied to the quantity of conventional electricity produced or indirectly used in the production process and consumption, both in exogenous and optimal conditions, as illustrated in Equation (2) as follows:

$$p_i^A = p_i + t^{CO_2}\delta_i \quad (2)$$

Where, p_i considers as price of fossil fuel (by industry, *i*) used in the production process directly or indirectly, t^{CO_2} considers a carbon intensity rate, δ considers as carbon coefficient in the energy usage.

In estimating the carbon price for conventional energy use, the study contrasts this with the renewable electricity sector's use of alternative inputs, which diminishes fossil fuel reliance and carbon intensity. Due to the absence of detailed sectoral production structure data in the input-output table, additional sources were tapped to determine the renewable energy electricity sector's production function, incorporating "markup factor" and "input cost share" as evaluative standards. These factors help calculate the extra costs of generating electricity from renewables compared to conventional sources, guiding the long-term production strategy within the renewable sector. To align the model's carbon intensity with targeted levels, the study selects a path for carbon intensity and adjusts the rate of shadow environmental policy reform within the simulation, indicating an adaptive approach that increases policy reform efforts as carbon levels drop.

2.8 Optimality Condition

This study used shadow environmental policy reform where there was '*no taxation*' applied specifically to Bangladesh economy rather used demand for the three energy types (fossil fuel, coal and gas) which follow from of the efficiency conditions by:

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[4]We referred carbon emission of $MtCO_2e$ (~carbon emission oil equivalent) as $MtCO_2$ generally.

$$h_t, \tau_t, w_t \equiv (1 - \alpha - v)Y_t/L_t \quad (3)$$

Where, h_t, τ_t, w_t used as proxy for $(1 - \alpha - v)Y_t/L_t$, and b_t are the scarcity rent of energy (e.g., such as fossil fuel or conventional oil, coal and gas)), the social cost of carbon (SCC) known as social damage and wage (i.e. the marginal product of labour), respectively, all in units of final goods. The scarcity rents on energy (e.g., fossil fuel, conventional oil, coal and gas) follow as form as indicated below:

$$h_t = j_t h_{t-1} \quad (4)$$

Here, $j_t = \frac{1}{\beta\gamma}\frac{Y_t}{Y_{t-1}}$. In case of full depreciation, $\iota = \kappa = 1$, this gross growth rate of the carbon shadow price equals the marginal product of capital, $j_t = \alpha Y_t/K_t$.

Therefore, we utilized carbon shadow price equals the marginal product of capital without any further taxation or environmental tax. If the marginal product of capital in the production function can be maintained by policy enforcement or environmental policy reforms, the energy intensity can be reduced over the long run with appropriate strategy execution[5].

2.9 Parameters

The model contains numerous parameters in its functions, with the values of the EOS parameters. The symbols in the table indicate where these parameters are utilized, and the "source" indicates the origin of the parameter values. While most of the *EOS* values are derived from GTAP database, we have made minor adjustments to align them with our model. As there is no reliable empirical estimate available, we assume *E_LND* to be 0.5.

2.10 Simulation Scenarios

The report includes two fundamental scenario simulations (Table 1): (1) first one being the ***Business-as-usual (BAU) scenario***, which is absence of any further desired interventions, and (2) the other one is the ***Steady State Green Growth (SSGD)*** or ***Sustainable Steady Growth (SSD)*** vision 2050 scenario, which is acting as a benchmark for BAU plus policy interventions.

To align the model's initial conditions with those of the "current policies scenario," we adjust certain exogenous parameters. In particular, the rates of energy intensity (AEEI) and total factor productivity (TFP) growth are validated to ensure congruence between the model's forecasts of GDP and carbon intensity and the definite state of the Bangladesh economy in 2020 (benchmark). To approximate the average GDP growth rate for the fiscal year 2020, we adjusted the TFP growth rate. In addition, the AEEI rate is modified to be near the carbon evaluation identified in the Bangladesh National Energy Policy, 2020-2050[6].

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[5] In order to achieve our objectives, we decided to implement a carbon shadow price that aligns with the marginal product of capital, without imposing additional taxes or environmental charges. The idea is to ensure that the productivity growth of capital remains intact by implementing effective policies and reforms, which will gradually lead to a decrease in energy intensity over time.

[6] In our estimation of emissions, we utilized a constant value of 47 $Mtco_2e$ for land-use, land-use change, and forestry (LULUCF) until 2050. It is important to note that all of our simulations include carbon emissions, including those from LULUCF. Furthermore, the application of CCS, specifically CCS-Y2065, aims to achieve the net-zero target by 2065, starting from 2045.

Table 1. Scenario lists in the model application

No	Simulation(s) and Scenario(s)	Remarks on the Simulation(s)
1	BAU	Business-as-usual scenario
2	SSGD/SSD	Steady State Green Growth

We assume that starting from 2025, there will be a shadow environmental policy reform (as proxy) in place to limit carbon intensity by using two (2) ways: (1) ***'Exogenous shadow environmental policy reform (capital's marginal product-C_mp)'***[7] and (2) ***'Optimal Green Growth'*** by using progressive rates of total factor productivity (TFP) growth and energy intensity (AEEI) efficiency from 2025. The optimal green growth scenario over the long run is based on green growth goals and targets. It must be noted that the optimal green growth is forecasted by taking into account three (3) proxy (*e.g., hidden and not displayed in Table 1 but included to serve as the basis for calibration assessment)* sub-scenarios: (i) *The Steady State Equilibrium Scenario* (SS BAU), (ii) *No Policy* (e.g., there is currently no action being taken that is related to the environment), and (iii) *Full INDC* (e.g., 45% of conditional emission reduction based on Nationally Determined Contributions).

In this study, we have also included a calculation in the model that incorporates a hidden setting where a consumption tax is implemented to incentivize consumers to maintain their purchasing power (PPP) intact[8]. In the swap proxy (e.g., *not displayed in Table 1 as well*) simulation commonly known as "lump-sum rebate setting," households PPP would not be affected for environmental policy reform. Thus, this situation does not change existing tax rates and is essentially the same as a straightforward other regular tax. The three proxy (*hidden*) alternatives involve adjusting taxes to maintain the existing GDP growth, with environmental policy strategy[9]. The impact of these scenarios considers various factors such as production functions, demand decisions by households, investment behavior, and the relationship between taxes and national fundamental economic variables.

The implementation of this approach requires careful consideration of various factors. Firstly, the production functions of industries need to be evaluated to understand their environmental impact and potential for resource efficiency[10]. Furthermore, the response of households to this policy reform is to be carefully observed for at least one fiscal year. Understanding the consumer behavior and demand decisions of households and how they respond to incentives can help design effective policy measures. For instance, the introduction of energy-efficient appliances can induce individuals to purchase these items and change consumption pattern toward greener direction. Furthermore, examination about other regular tax and national economic variables are well calculated. The impact of shadow price of an equivalent of capital's marginal product adjustment on GDP growth, investment rate and nation-wide economic strength are framed in determine. Aimed with a shadow environmental policy reform design, perpetual GDP growth is well maintained while sustainability is promoted. By aligning the economic incentive with environmental objectives, the transition into a green economy is also facilitated (e.g., utilising BAU and SSGD/SSD).

[7] We assume that Bangladesh will implement environmental policy from 2025 and onwards that we consider as shadow price of an equivalent of capital's marginal product as proxy. To reach our goals, we opted for implementing a carbon shadow price that corresponds to the capital's marginal product in the production process. This approach doesn't involve imposing extra taxes or environmental fees. Our aim is to preserve the efficiency growth of capital by introducing efficient policies and reforms. As a result, we anticipate a gradual reduction in energy intensity over the long term.

[8] The model incorporates an income tax on the household's work-related income, which acts as a disincentive for individuals to work. However, by reducing income taxes, individuals are encouraged to work more, resulting in an expansion of the labor supply. This, in turn, leads to increased production and ultimately benefits the economy.

[9] This shadow tax reform is equal to the marginal rate of damage and the marginal rate of return on investment.

[10]For example, in the case of renewable energy, it is important to assess the current capacity and explore opportunities for further development.

SECTION 3. FINDINGS ON GREEN INDUSTRIES DIAGNOSTIC

3.1 Modeling Results and Findings

The baseline scenario, referred to as the BAU (Business-as-Usual) scenario, does not involve any explicit regulation of carbon intensity reduction (or shadow environmental policy reform) except '*existing policy*'. Certain exogenous parameters of the model are adjusted in order to achieve a BAU equilibrium that accurately reflects the circumstances under the "current or existing policies scenario"[11]. This scenario incorporates an exogenous shadow environmental policy reform, viewed as a top-down policymaker decision, and forecasts Total Factor Productivity (TFP) growth and Autonomous Energy Efficiency Improvement (AEEI) based on historical national trends. The aim is to replicate a steady state followed by BAU growth rates for GDP, facilitating an evaluation of how carbon intensity regulations or policy reforms could impact Bangladesh's economy.

Under the "No Policy" situation, carbon emissions are shown to incrementally increase from 0.37 Mt in 2020 to 2.09 Mt by 2050, demonstrating a continuous rise in emissions and carbon intensity percentages over the years, reflecting a scenario with no interventions to curb carbon emissions. In contrast, in the SSGD/SSD scenarios, we implement a shadow environmental policy reform to achieve a 15-45% reduction (e.g., following NDC targets and with elements of low carbon pathways from Bangladesh Delta Plan 2100) in carbon intensity by 2050. This reduction does not include the use of carbon capture and storage (CCS) without specific and extreme targets. The reduction rate is measured against a benchmark year of 2020. This scenario projects a marginal improvement in the economy's intensity/output, suggesting that despite economic growth, environmental sustainability enhancements are limited. The study suggests that implementing environmental policies, including CCS and Land Use, Land-Use Change, and Forestry (LULUCF) initiatives, under the SSGD/SSD scenario could foster sustainable economic growth and encourage higher long-term investments (Figure 5).

The Steady State Green Growth (SSGD/SSD) strategy includes investments in renewable energy, enhancing resource efficiency, enforcing stricter environmental regulations, and promoting clean technologies to achieve a sustainable and eco-friendly economy. It focuses on reducing carbon footprints and adopting cleaner production methods, aiming to decrease the economy's intensity/output for a greener future, as demonstrated by the study's findings. The model examines how macroeconomic variables shift from the BAU scenario towards SSGD/SSD due to shadow environmental policy reform, indicating changes like reduced corporate taxes to spur investment and capital accumulation, thus increasing production and output. To match the model's GDP growth rate with Bangladesh's recent economic data showing an average growth rate of about 6.5%, adjustments are made to the TFP growth rate[12]. This reconciliation between the model's projections and forecasted GDP growth rates involves modifying the TFP growth rate[13], which accounts for the efficiency and technological advancements contributing to economic growth, to accurately reflect Bangladesh's economic trajectory and examine the effects of carbon intensity regulations and policy reforms.

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[11] To overcome the effects of external shocks in 2020 (e.g., like in 2020 GDP growth rate was uneven due to COVID-19 impact), we employed market-adjusted GDP growth (referred to as GDPm) instead of nominal GDP. Throughout the study, we refer to GDPm as simply GDP.

[12] We utilized utility and shadow value to assess the impact of taxation, as any tax imposition is seen as having a negative effect on the economy and consumers. While utility is considered the most crucial variable for measuring a country's welfare from a theoretical standpoint, it is not directly observable and therefore challenging to use as a policy criterion. In practice, GDP is often used as a policy indicator, as it provides information on the impact of policies on domestic production. This makes it more useful for policy makers, even though it does not capture the value of leisure.

[13] While we acknowledge that GDP and income may not necessarily be superior measures of welfare, we recognize their limitations in reflecting household welfare. Nonetheless, we provide analysis on the effects on GDP and income as they are commonly utilized as significant policy indicators in practical policy formulation.

In figure 5, orange line represents the Business as Usual (BAU) scenario, where no new policies or measures are implemented to reduce emissions intensity. Under BAU, the emissions intensity is projected to decline gradually over time due to autonomous efficiency improvements, but at a relatively slow rate. The blue line represents the SSGD scenario, which assumes the implementation of policies and measures aimed at significantly reducing emissions intensity and transitioning towards a low-carbon economy. In this scenario, the emissions intensity declines much more rapidly compared to BAU, indicating a more aggressive transition towards cleaner and more efficient production processes.

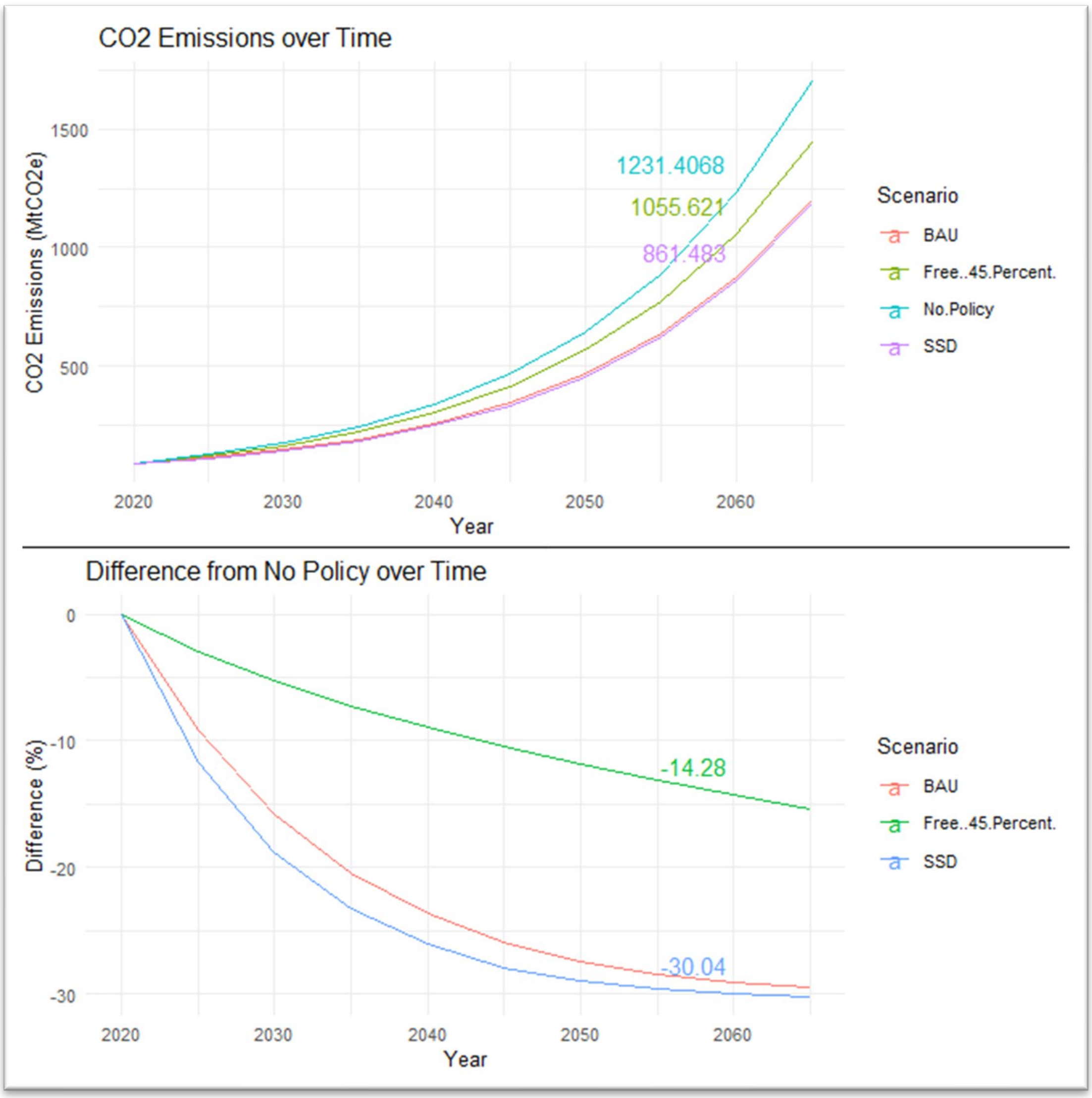

Figure 5. Intensity/per output of the economy from 2020-2050

3.2 BAU equilibrium

The analysis under the BAU scenario reveals significant insights into the future trajectory of GDP growth and carbon emissions in the absence of environmental policies ("No Policy" scenario) and with the implementation of current or potential policies, excluding green taxation. Initial projections for 2020 without any policy intervention show a GDP of $373.90 billion and carbon emissions at 92.54 million tons, with a carbon intensity of 0.37. This scenario forecasts a steady increase in GDP reaching $2,487.77 billion by 2050, alongside a rise in carbon emissions to 644.57 million tons, resulting in a growing carbon intensity up to 2.09, indicating a worsening carbon efficiency over the next three decades. Conversely, under a scenario incorporating existing or potential policies aligned with Intended Nationally Determined Contributions (INDCs) targets, the economy is expected to grow consistently at a rate of 6.51-6.52% annually, with the GDP similarly expanding from $373.90 billion in 2020 to $2,487.77 billion by 2050. However, this scenario shows a modest improvement in carbon intensity, decreasing from 0.37 in 2020 to 0.19 by 2050, reflecting a slight enhancement in carbon efficiency despite economic growth. These findings highlight the limited impact of current or potential policies on improving carbon efficiency under the BAU scenario, emphasizing the need for more forceful measures to address carbon emissions effectively (Figure 6).

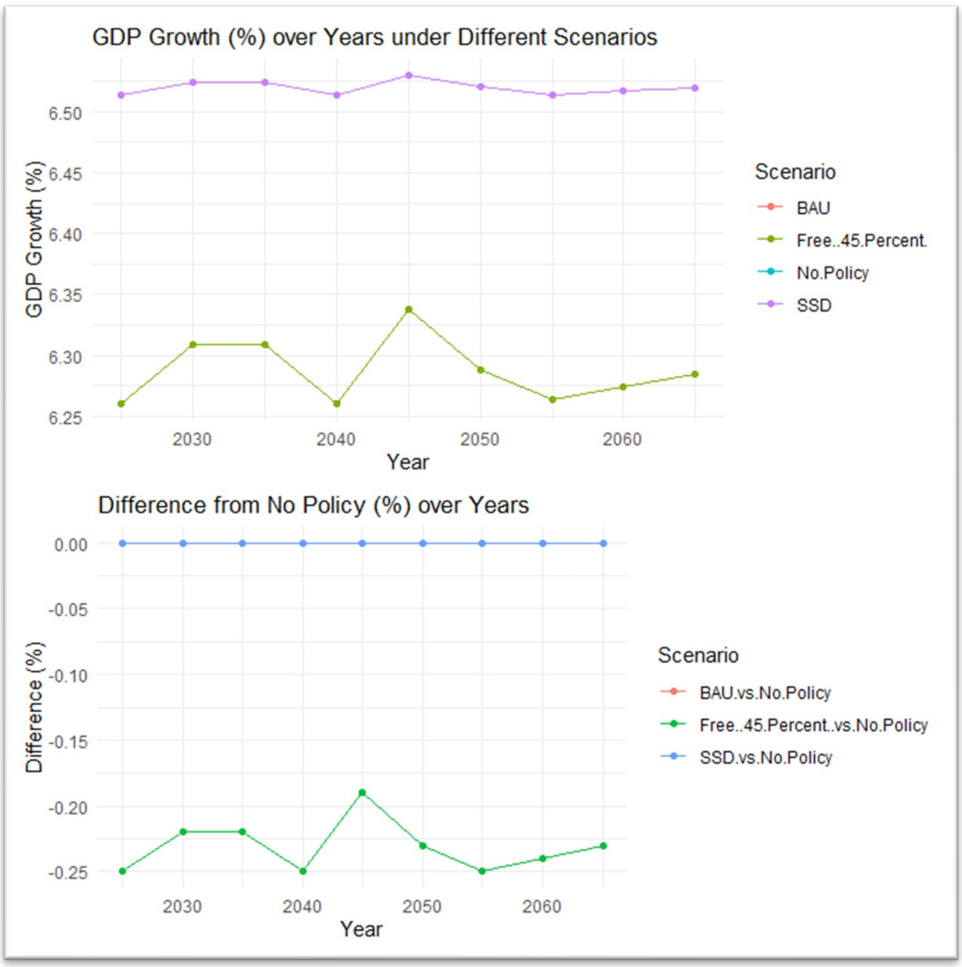

Figure 6. GDP ($ Billion) and carbon (Mt) emission 'without any current or future policy'

This implies that the current or prospective policies in place, such as the adoption of partial INDC targets, may not be sufficient to significantly reduce carbon emissions and address the issue of climate change. Despite the growth in GDP, the high carbon intensity implies that the economy continues to heavily rely on carbon-intensive industries and practices. In order to achieve substantial reductions in carbon emissions, it may be necessary to implement additional policies, such as a green environmental policy. This type of policy aims to internalize the environmental costs associated with carbon emissions, thereby incentivizing industries to adopt more sustainable practices and technologies. Thus, while the economy grows, its environmental impact in terms of carbon emissions per unit of output is only marginally reduced. However, based on the small improvements in carbon intensity, we can infer that the BAU scenario does not focus or prioritize sustainability or significant carbon reduction measures. It is obvious that the BAU scenario alone is not sufficient to achieve a sustainable and environmentally friendly economy (Figure 5).

The study analysis reveals a consistent economic expansion under the business-as-usual (BAU) scenario, but it points out a slight improvement in carbon intensity, indicating that while the economy grows, the reduction in carbon emissions per unit of output is only slight. This implies that although there has been economic growth, there has been no substantial improvement in terms of the environmental impact and carbon efficiency expected by Bangladesh's INDC goal after the Paris agreement in 2015. The study advises that implementing a green environmental policy by pricing carbon emissions could significantly shift businesses and individuals toward more energy-efficient and cleaner options, potentially leading to a more substantial decrease in carbon intensity. However, the effects of such policies on GDP growth need careful consideration to maintain a balance between economic expansion and environmental sustainability.

Under the BAU scenario, both consumption and investment are projected to show steady growth rates of 6.53% and 6.51% per year, respectively, from 2020 to 2050. Starting from a baseline of $234.33 billion for consumption and $69.61 billion for investment in 2020, these figures are expected to rise to $1,561.21 billion for consumption and $463.74 billion for investment by 2050. These projections, especially investment highlighted in Figure 7 along with employment, illustrate a continuous increase in economic activities and suggest a positive trajectory for the economy without considering any specific environmental interventions or policy impacts on sectoral distribution or the overall sustainability of growth patterns.

The employment in Bangladesh is projected to consistently grow from 77.77 million people in 2020 to 160.39 million by 2050, with an annual growth rate of approximately 2.44% under the BAU scenario (Figure 7). This scenario indicates a steady increase in job opportunities while also highlighting a gradual reduction in carbon intensity, demonstrating progress towards more sustainable practices. Meanwhile, carbon emissions are expected to increase from 92.54 million tons in 2020 to 468.65 million tons by 2050, despite a declining trend in emission intensity, suggesting improvements in emissions per unit of economic output, partially attributed to achieving INDC goals (Figure 5). However, the analysis does not delve into the specifics of how employment distribution might change across different sectors or the precise drivers behind the reductions in emission intensity.

The potential influence of green environmental policies on emission intensity underscores the need for targeted strategies that encourage businesses to adopt lower carbon practices, suggesting a pathway for further reducing emissions alongside economic growth. Figure 7 shows the employment rate, which is the level of employment in millions of people and its growth rate. It indicates that employment is consistently increasing over the projection period under the BAU scenario. The growth rate remains continual at about 2.44% per year. This suggests that there is a positive relationship between economic growth and employment, as more people are being employed as business activity continues.

However, Figure 5 (lower panel) provides information on emissions growth rates[14]. The emissions are projected to increase in absolute terms over the projection period, but the emission

[14] It also includes the emission intensity rate, which is the amount of emissions per unit of output.

intensity rate is constantly fluctuating over time. This indicates that even though emissions are increasing due to economic growth, the emission intensity rate is uneven. Therefore, there is a need for a more specific aim in order to fulfill the voluntary commitment made under the Paris agreement. It is important to note that these comparisons are based on the BAU scenario, which assumes the continuation of current business activity without specific interventions or policies. Therefore, different scenarios or policy interventions may have different effects on both employment and emission intensity which are evaluated further in scenario analysis.

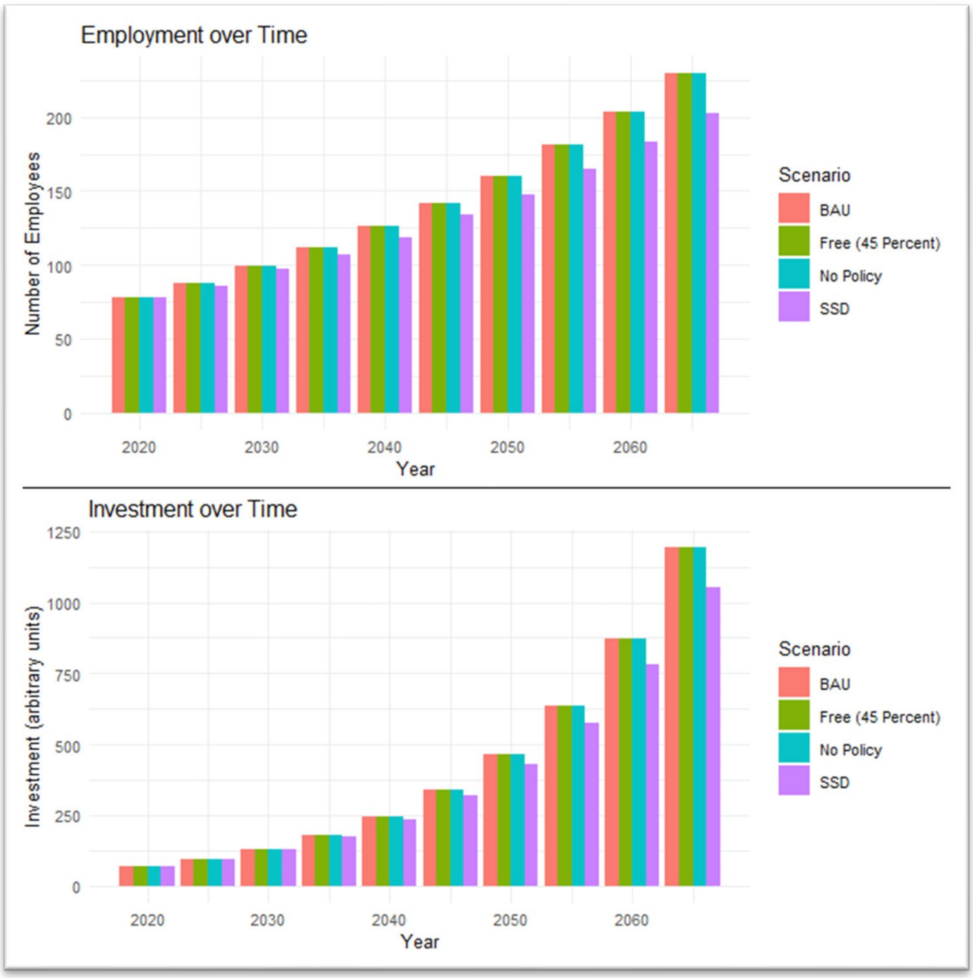

Figure 7. Path of employment (number- in million) and investment ($ billion) over time under BAU

3.3 Scenario Analysis

This study suggests that by implementing a shadow environmental policy reform, a reduction in carbon intensity can be achieved after 2030. This study refers to this scenario as the Steady State Green Growth (SSGD/SSD) vision 2050, which combines Bangladesh's NDC target[15], low carbon

[15]Bangladesh aims to achieve a 15% reduction in greenhouse gas emissions below the business-as-usual scenario by 2030. This target could be increased to 30% with international support.

pathways[16], and elements of the Bangladesh Delta Plan 2100[17]. The findings acknowledged that the specific shadow environmental policy reform rates required for this reduction are shown at all levels. Moreover, it is observed that these policy rates show similarities across diverse environmental policy reform scenarios, suggesting that a significantly elevated shadow environmental policy reform rate is essential in order to efficiently mitigate carbon intensity to reach the NDC target and beyond.

According to Figure 8, the GDP and carbon emissions in Bangladesh are expected to change over time under the Steady State Green Growth (SSGD/SSD) vision. In 2020, the GDP is projected to be $373.90 billion, while carbon emissions are estimated to be 92.54 million tons. By 2025, the GDP is expected to increase to $512.60 billion, representing a growth rate of 6.51%. This indicates a positive trend in economic growth. At the same time, carbon emissions are projected to increase to 114.44 million tons. However, despite the increase in emissions, the carbon intensity (carbon emissions per unit of GDP) is expected to decrease by 2.52% compared to 2020. This suggests that there is a reduction in the carbon emissions per unit of economic output, indicating progress towards more sustainable growth.

In 2030, the GDP is forecasted to reach $703.11 billion, with carbon emissions rising to 145.84 million tons. The growth rate of both GDP and carbon emissions remains relatively constant at 6.52%. However, carbon intensity is expected to decrease further to -1.68%, indicating a reduction in carbon emissions per unit of GDP. This shows that despite the increase in total emissions, emission intensity per unit is reducing. Thus, the economy is becoming more efficient in terms of carbon usage. Looking ahead to 2035, the GDP is anticipated to reach $964.41 billion, while carbon emissions are projected to be 190.26 million tons. The growth rate and carbon intensity continue to exhibit similar trends as in previous years. This demonstrates a consistent pattern of sustainable economic growth with relatively low carbon emissions under the Steady State Green Growth.

By 2040, Bangladesh's GDP is expected to rise to $1,322.17 billion, with carbon emissions dropping to 252.60 million tons, indicating a stable growth rate of 6.51% and a decrease in carbon intensity to -1.05%. This trend suggests that the country will continue to experience economic growth while also becoming more carbon-efficient. By 2050, the forecast suggests the GDP will increase to $2,487.71 billion with carbon emissions at 461.13 million tons, maintaining its growth rate with carbon intensity further decreasing to -0.78%. This progression demonstrates that through the implementation of the shadow environmental policy reform and the SSGD/SSD vision, Bangladesh is on a path to achieve sustainable economic growth alongside significant reductions in carbon emissions, ensuring a more sustainable and eco-friendly development trajectory.

According to study findings, the path of consumption and investment in Bangladesh under the Steady State Green Growth (SSGD/SSD) vision is expected to change over time. Starting with a consumption of $234.33 billion and an investment of $69.61 billion in 2020, both metrics are expected to rise to $321.58 billion and $95.12 billion by 2025, respectively, showcasing a positive trend in economic activities. This growth trajectory continues, with consumption expected to reach $441.10 billion and investment to hit $131.02 billion by 2030, further increasing to $605.09 billion in consumption and $179.33 billion in investment by 2035. By 2040, consumption is forecasted at $829.47 billion and investment at $246.28 billion, indicating robust economic growth. This pattern of steady growth persists through to 2045 and 2050, with consumption reaching $1,137.96 billion and $1,561.15 billion, and investment escalating to $338.02 billion and $463.43 billion, respectively. These

[16] Low-carbon targets include increasing the share of renewable energy in the electricity mix, promoting energy efficiency measures, improving public transportation networks, implementing sustainable waste management practices, and enhancing forest cover through afforestation and reforestation initiatives.

[17] By integrating the Bangladesh Delta Plan 2100 with its NDC targets, the government aims to work towards a sustainable and climate-resilient future, reducing the country's carbon footprint and building a more prosperous and resilient economy.

projections highlight the potential of the SSGD/SSD vision to significantly enhance consumption and investment, underpinning sustainable economic development and progress in Bangladesh.

Figure 8 displays the information on employment, emissions, and intensity rate under the SSGD/SSD framework. The graph illustrates the employment data in millions of people. This data reinforces the notion that the SSGD/SSD vision plays a significant role in fostering employment opportunities and decreasing emission intensity. Ultimately, these outcomes contribute to sustainable economic development and progress in Bangladesh. Under the SSGD/SSD framework, employment in Bangladesh has been steadily increasing over time. In 2020, there were 77.77 million people employed, indicating a significant workforce contributing to the country's economic development. This steady rise in employment demonstrates the positive impact of the SSGD/SSD vision on promoting job opportunities and reducing unemployment rates. Moreover, this framework also emphasizes the reduction of emission intensity, which refers to the amount of greenhouse gas emissions produced per unit of economic output. By adopting sustainable practices and promoting green technologies, Bangladesh has managed to decrease its emission intensity over the years. Reducing emission intensity is crucial for sustainable economic development as it signifies a decoupling of economic growth from environmental degradation. The SSGD/SSD vision is instrumental in achieving this goal by encouraging the implementation of eco-friendly policies and supporting the development of green industries. By focusing on sustainable economic development and advancements, Bangladesh can achieve significant progress while minimizing its impact on the environment. The SSGD/SSD framework provides a comprehensive approach to address employment and emission challenges, ensuring long-term economic growth and environmental sustainability.

Our findings indicate that in 2020, the emissions amounted to 92.54 Mt. Moving to 2025, the employment figures decreased slightly to 87.81 million, representing a growth rate of 2.46%. In contrast, the emissions decreased to 114.44 Mt, with a negative growth rate of -2.52%. Looking ahead to 2030, the employment figures increased to 99.15 million, showing a growth rate of 2.44%. Simultaneously, the emissions decreased to 145.84 Mt, indicating a negative growth rate of -1.68%. In 2035, employment continued to rise to 111.73 million, with a growth rate of 2.44%. On the other hand, emissions decreased to 190.26 Mt, demonstrating a negative growth rate of -1.28%.

By 2040, the SSGD/SSD framework shows employment surging to 126.01 million with a steady growth rate of 2.44%, while emissions fall to 252.60 Mt, reflecting a -1.05% decrease. This trend continues into 2045, with employment climbing to 142.12 million and a 2.44% growth rate, and emissions further reducing to 339.71 Mt, showing a -0.89% decrease. By 2050, employment is projected to reach 160.37 million, increasing slightly to a 2.45% growth rate, alongside emissions dropping to 461.13 Mt, which marks a -0.78% decrease. The figure highlights a steady job growth and a consistent reduction in emissions, illustrating strides towards sustainable and green development under the SSGD/SSD framework. While employment trends indicate robust job creation and a strong labor market from 2025 to 2050, the declining emission trends signify effective greenhouse gas reduction and a shift to sustainable practices. However, the absence of intensity rate data limits a comprehensive assessment of emission reduction efficiency and the overall environmental impact of economic activities, suggesting that for a thorough environmental impact evaluation, incorporating the intensity rate with emissions data is essential.

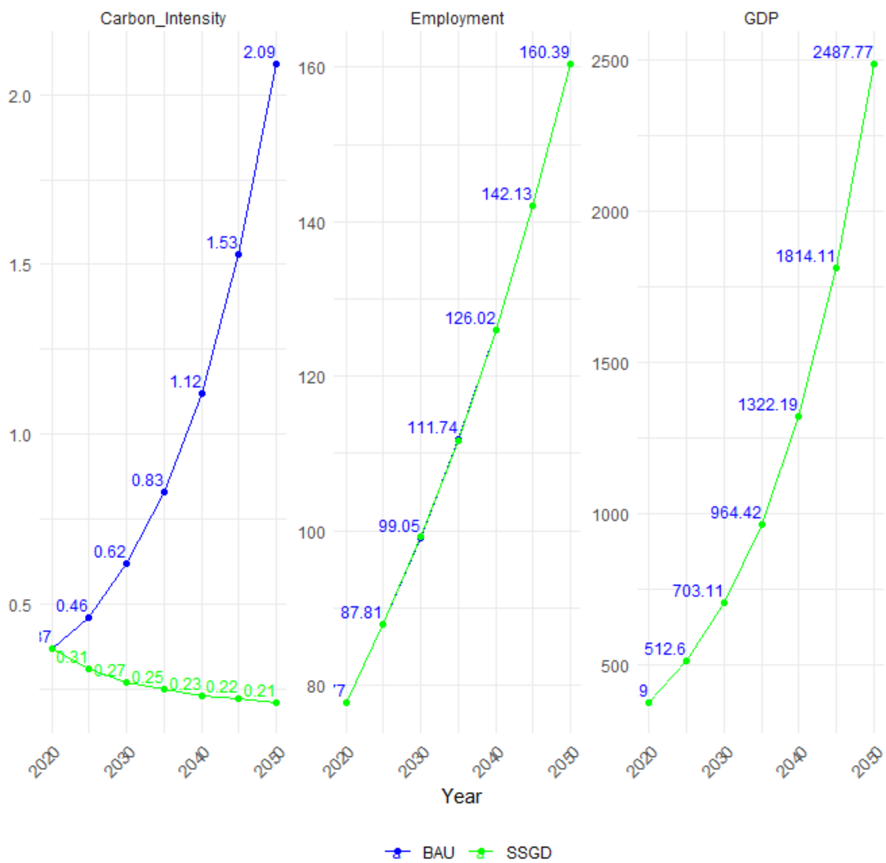

Figure 8. GDP, employment, and carbon intensity under BAU vs SSGD/SSD scenario

3.4 Comparative simulations between BAU and SSGD/SSD

Comparing the "BAU" and "SSGD/SSD" scenarios reveals both predicted GDP and carbon emissions increase over time, yet the "SSGD/SSD" scenario slightly outperforms in carbon intensity rates, suggesting a more efficient carbon use relative to GDP growth. The "BAU" scenario projects GDP growth from $373.9 billion in 2020 to $2,487.77 billion in 2050, with carbon emissions rising from 92.54 Mt to 644.57 Mt, and carbon intensity percentage climbing from 0.37% to 6.41%. Conversely, the "SSGD/SSD" scenario expects a similar GDP rise, from $373.9 billion to $2,487.71 billion, but with a lesser carbon emission increase from 92.54 Mt to 461.13 Mt, and a carbon intensity percentage from 0.37% to 6.52% in the same timeframe. Although both scenarios exhibit similar GDP growth rates between 6.51% and 6.53%, the "SSGD/SSD" scenario forecasts marginally lower carbon intensity rates, from -0.78% to -2.52%, versus the BAU scenarios. This comparison highlights the minimal economic growth impact under the "SSGD/SSD" framework until 2040, with a minor GDP decrease noted by 2045, suggesting the "SSGD/SSD" framework's negligible economic growth effect, evidenced by the nearly parallel growth trajectories in both scenarios (Figure 8).

Looking at employment, both scenarios project an increase in the number of employed individuals over time (Figure 8). Under the "BAU" scenario, employment is projected to increase from 77.77 million in 2020 to 160.39 million in 2050, with growth rates ranging from 2.44% to 2.45%. In contrast, under the "SSGD/SSD" scenario, employment is projected to increase from 77.77 million in 2020 to 160.37 million in 2050, with growth rates ranging from 2.44% to 2.45%. Under the "BAU" scenario, carbon emissions are projected to increase from 92.54 Mt in 2020 to 468.65 Mt in 2050, with intensity rates ranging from 0.19% to 1.56%. In the "SSGD/SSD" scenario, carbon emissions are projected to 92.54 Mt in 2020 to 461.13 Mt in 2050, with intensity rates ranging from -2.52% to -0.78%. Overall, the "SSGD/SSD" scenario shows better performance in terms of carbon intensity rates compared to the "No Policy or BAU" scenarios.

From Figure 8, we can see that the "BAU" scenario forecasts a rise in GDP from $373.9 billion in 2020 to $2,487.77 billion in 2050, with carbon emissions also expected to increase from 92.54 Mt to 644.57 Mt within the same period. Carbon intensity, or emissions per dollar of GDP, is predicted to climb from 0.37 to 2.09, and the carbon intensity percentage is set to reach 6.41% by 2050 indicating a no significant improvement in emission reduction relative to GDP growth. The "SSGD/SSD" scenario, in contrast, mirrors this upward GDP and emissions trend but with marginally better carbon intensity rates, suggesting a more efficient carbon use in GDP growth. While both scenarios show employment growth, suggesting job creation potential in transitioning towards a low-carbon economy, the "SSGD/SSD" scenario implies a need for greater emission and carbon intensity reductions to address climate change effectively.

3.5 Sectoral comparative simulations between BAU and SSGD/SSD

3.5.1 Sectoral emission intensity and share of GDP

The projections within Figure 9 highlight a concerning trend toward diminishing energy efficiency across multiple sectors, from 2020 through 2035, suggesting an escalating demand for energy despite efforts to mitigate consumption through more sustainable practices. For example, the agriculture, forestry, and fishery sector are anticipated to witness a modest yet steady rise in energy intensity, with percentages incrementing from 0.50% in 2025 up to 0.79% in 2035, hinting at a decreasing trend in energy efficiency over time. Similarly, the Energy Intensive Manufacturing Sectors (EIS) are projected to experience an increase in energy intensity from 0.72% in 2025 to 1.15% by 2035, indicating a significant decline in energy efficiency and a consequent surge in energy demand for the same level of output. In contrast, the petroleum products sector demonstrates a stable energy intensity profile, with changes remaining below 0.1% across all observed years, suggesting minimal alterations in energy requirements. The textiles and textile products sector, along with the construction and services sectors, are also expected to face growing energy intensity, with projections ranging from 0.62% to 0.99% for textiles and from 1.04% to 1.65% for construction and services between 2025 and 2035. This trend of deteriorating energy efficiency, particularly pronounced in the latter sectors, calls for a strategic response to enhance energy conservation and promote the adoption of cleaner, more sustainable technologies to address the increased energy demands anticipated across these diverse sectors of the economy.

It's worth noting that while the production of coal products and fossil fuels is expected to decline, it does not mean that they will no longer be used at all. Certain industries still rely on these resources for specific purposes, especially in cases where there are limited alternatives available. Nonetheless, the overall decrease in their production aligns with the objective of promoting green growth and transitioning towards a more sustainable and low-carbon economy.

Figure 9 provides information on the sectoral share of GDP simulations (year-on-year changes in the sector's share of GDP) by SSGD/SSD compared to the Business-as-Usual (BAU). The study outcomes indicate that Agriculture, forestry, and fishery sector's share of GDP is projected to increase from 0.13% in 2020 to 0.20% in 2025, representing a year-on-year change of 0.07%. Similarly, the sector's share is expected to further increase to 0.21% in 2030, 0.21% in 2035, 0.19% in 2040, 0.27% in 2045, and eventually reach 0.17% in 2050, with varying year-on-year changes over this period. For the textiles and textile products sector, its share of GDP in 2020 was 0.17%. By 2025, it is projected to increase to 0.25%, representing a year-on-year change of 0.08%. This upward trend continues as the sector's share is expected to reach 0.27% in 2030, with a year-on-year change of 0.02%. By 2035, it is projected to remain stable at 0.27%, while in 2040, it decreases slightly to 0.25%.

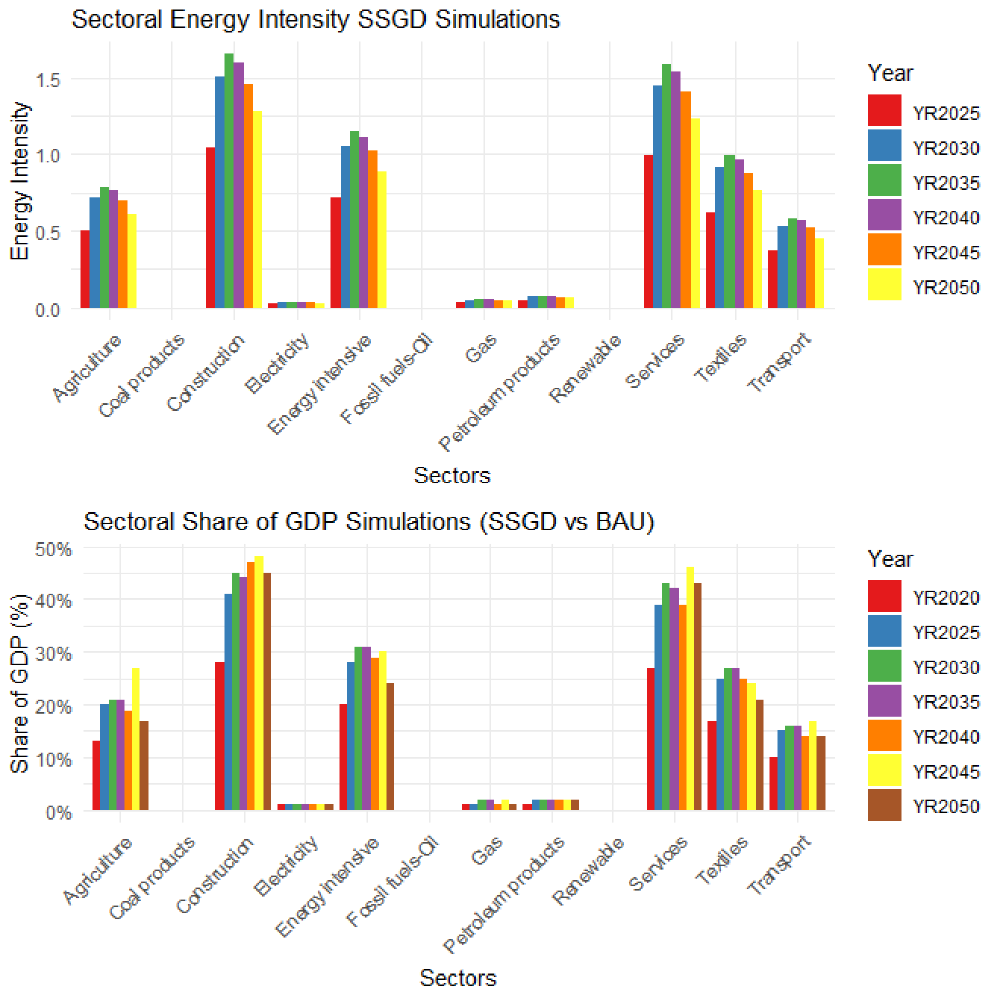

Figure 9. Sectoral energy intensity SSGD/SSD simulations (carbon content/output)

In the construction sector, its share of GDP was 0.28% in 2020. This is expected to increase significantly to 0.41% in 2025, representing a year-on-year change of 0.13%. By 2030, the sector's share of GDP is projected to be 0.45%, with a year-on-year change of 0.04%. This trend continues as the sector's share reaches 0.44% in 2035 and 0.47% in 2040. By 2045, it further increases to 0.48% before stabilizing at 0.45% in 2050. Similarly, the Services sector's share of GDP in 2020 was 0.27%. By 2025, it is projected to increase to 0.39%, with a year-on-year change of 0.12%. In 2030, the share is expected to reach 0.43%, with a year-on-year change of 0.04%. By 2035, the sector's share of GDP is projected to be 0.42% and then decrease slightly to 0.39% in 2040. In 2045, there is a significant increase to 0.46%, and by 2050, the share decreases slightly to 0.43%. Therefore, based on our analysis of the green industry and our objective of achieving sustainable growth, it can be concluded that the sector's focus on low carbon and environmentally friendly practices does not hinder the growth of industries that do not heavily rely on conventional and energy-intensive practices.

3.5.2 Economic output under BAU and SSGD/SSD

Figure 10 (upper panel) presents sectoral simulations for the BAU (business as usual) scenario for various sectors from 2025 to 2050. Agriculture, textiles, and services sectors are anticipated to maintain a steady growth trajectory, albeit with some fluctuations in value over the years. In contrast, petroleum products, gas supply, and conventional electricity sectors face declines, indicating a challenging outlook under the BAU scenario. Energy-intensive manufacturing and coal products sectors exhibit moderate growth, suggesting resilience to a degree. The transport sector shows a negligible change initially, followed by slight increases, while renewable electricity (nuclear) experiences minimal growth, hinting at slow adoption.

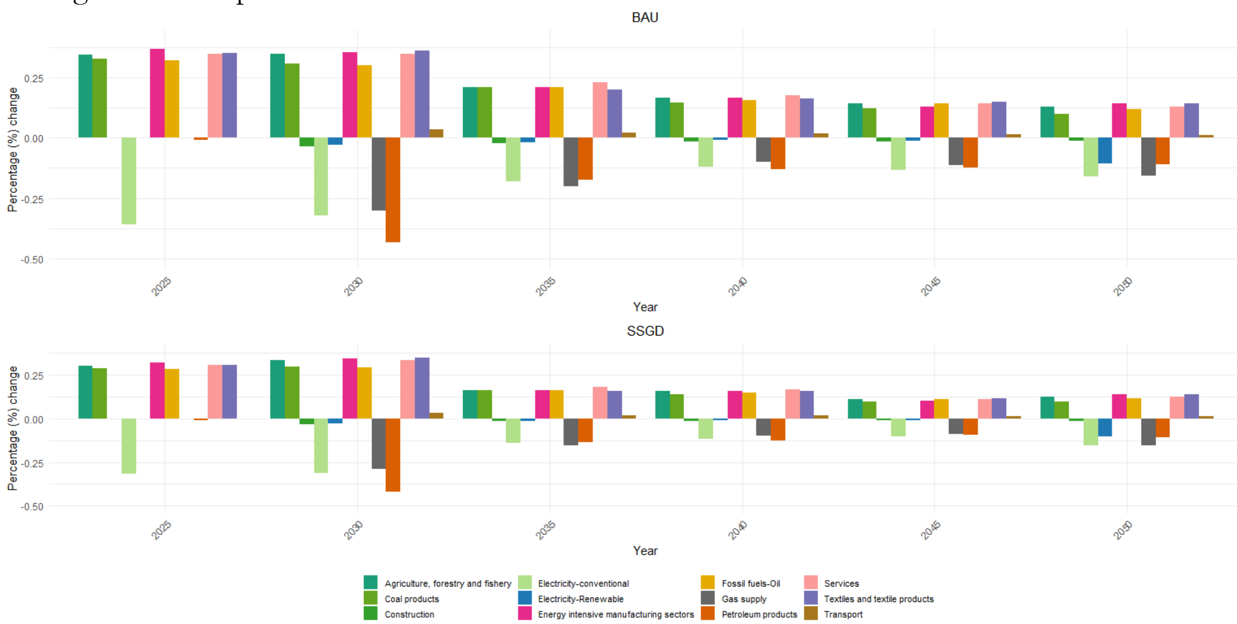

Figure 10. Economic output under BAU and SSGD/SSD

Figure 10 (lower panel) also outlines sectoral forecasts under the SSGD/SSD scenario from 2025 to 2050, showing the agricultural, forestry, and fishery sector's value growing from \$68.91 billion in 2025 to \$413.47 billion by 2050. Other sectors like petroleum products, textiles, energy-intensive manufacturing, transportation, gas supply, renewable and conventional electricity, construction, and services also exhibit gradual growth over this period. However, this growth is somewhat tempered compared to the BAU scenario, particularly for energy-intensive sectors such as coal production and fossil fuel extraction, which see reductions aligning with green growth ambitions. These adjustments stem from heightened investments in renewable energy (solar, wind, hydropower) favored for their lower carbon footprints and sustainability. The shift towards renewables and enhanced energy efficiency across the economy leads to reduced demand for coal and oil as cleaner energy sources become more prevalent[18].

The values in Figure 10 for the SSGD/SSD scenario are slightly higher than the values in the BAU scenario except coal products, fossil fuels-oil, gas supply. The increasing values in each sector indicate the expected growth and economic activity under the SSGD/SSD scenario. It suggests that if sustainable and socially inclusive practices are implemented, the sectors will experience steady

[18] It is important to note that the decline in the production of coal products and fossil fuels does not mean a complete cessation of their use. These resources are still required for certain applications, especially in industries that have limited alternatives. However, the overall reduction in their production aligns with the goal of achieving green growth and transitioning towards a more sustainable and low-carbon economy.

growth over time. These simulations may provide insights into the potential benefits of sustainable development strategies for each sector. While the decrease in the production of coal products and fossil fuels may lead to some short-term economic challenges and adjustments in affected industries, it also presents opportunities for diversification and investment in the renewable energy sector. This can create new jobs, stimulate innovation, and improve environmental sustainability in the long run.

3.6 Sectoral export and imports (net exports)

Figure 11 shows the results for net exports by sector under the SSGD/SSD scenario, compared to BAU values, measured in billion dollars. The values represent the percentage changes compared to the year 2020 (Table A-2: Appendix). The sectoral net exports in the BAU scenario shows uneven trends. In 2020, the country had a positive trade balance in agricultural products (164.60 billion), textiles & garments (28,248.20 billion), manufacturing (32,683.42 billion), coal (7.41 billion), oil (12.62 billion), transportation (360.58 billion) and services (11,081.39 billion). However, the findings indicate a negative trade balance in natural gas (-131.22 billion), electricity (nuclear) (-2.64 billion), and construction (-2,338.69 billion), indicating that it imported more of these goods and services than it exported. Thus, it is evident that agriculture, coal, petroleum, energy-intensive manufacturing sectors, gas, electricity (nuclear), electricity conventional, construction, and services all show a decrease trend in net exports. The textiles & garments, gas, and transport sectors exhibit fluctuating net exports throughout the period from 2020-2050.

In contrast, sectors like petroleum products, gas supply, and construction are projected to experience declines in net export values, reflecting challenges in these areas under the sustainability focused SSGD/SSD approach. Energy-intensive manufacturing and renewable energy sectors display mixed outcomes, with modest increases suggesting a nuanced impact of sustainable policies on these industries. Sectors such as agriculture, coal, petroleum, and energy-intensive manufacturing will face challenges and potential declines in export values. Sectors like textiles and garments, gas supply, and transport will have varying levels of export growth or decline. Meanwhile, sectors like petroleum products, gas supply, and construction will experience declines. The decrease in net exports is more pronounced in the sustainable development scenario (SSGD/SSD) compared to the business-as-usual (BAU) scenario, mainly because of the difficulties faced in achieving sustainability. However, while certain sectors may face challenges, the overall move towards a low-carbon economy under the SSGD/SSD scenario presents potential benefits such as the creation of green jobs and the promotion of domestic consumption and exports in emerging sustainable sectors.

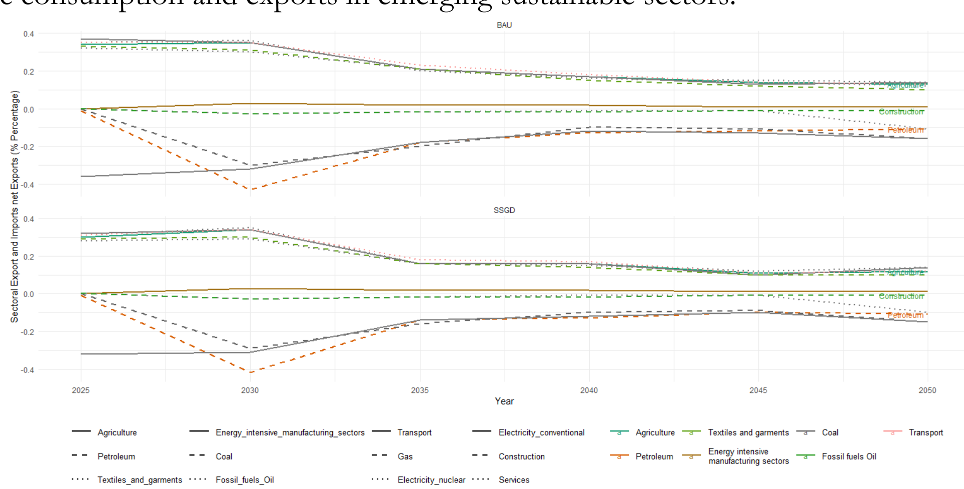

Figure 11. Sectoral export and imports (net exports)

The decline in Bangladesh's net exports can be attributed to various factors. One reason is the heavy dependence on imported raw materials and intermediate goods, particularly in the textile and garment sector. This reliance on foreign inputs leads to higher production costs and limits the country's ability to fully exploit international markets. Another factor is the lack of diversification in the export basket, with ready-made garments dominating the sector. This reliance on a single industry makes Bangladesh susceptible to changes in global demand and competition from other low-cost manufacturing countries. Additionally, Bangladesh primarily exports raw or semi-processed materials instead of finished products, resulting in limited value addition and decreased earnings. Furthermore, inadequate investment in research and development and innovation further hinders the development of higher-value products. Despite the presence of obstacles, the adoption of a sustainable development approach can yield favorable results and prospects in the future if an appropriate policy takes place, such as the generation of environmentally friendly employment opportunities which discussed in policy implications and recommendations section.

SECTION 4. POLICY IMPLICATIONS AND RECOMMENDATIONS

4.1 Observations and Context

This study focuses on the decline of Bangladesh's international competitiveness in terms of green growth and sustainable development. It highlights the obstacles to green growth and emphasizes the need for new strategies and instruments to promote inclusive and sustainable economic pathways. The study thus examines the challenges faced by Bangladesh, including declining social indicators, increasing exclusion, and slow creation of green jobs. It also stresses the potential opportunities in the decarbonization process and the importance of considering the informal sector in environmental policy. The study contributes to empirical findings by assessing the efficiency and impact of production, evaluating the economic efficiency of producing sectors, and estimating job creation. Overall, the study aims to inform policymakers and achieve the strategic objective of green growth in Bangladesh. To reach the study goal, the analysis in the study focuses on comparing BAU and SSGD/SSD scenarios. These scenarios are used to assess the potential impacts of policy interventions on the economic and environmental sustainability of Bangladesh.

To ensure that the model's forecasts align with the actual state of the Bangladesh economy in 2020, the study adjusts certain exogenous parameters. Specifically, the rates of energy intensity and total factor productivity (TFP) growth are validated to ensure that the model's projections of GDP and carbon intensity are realistic and accurate. The study also approximates the average GDP growth rate for the fiscal year 2020 by adjusting the TFP growth. This adjustment incorporates the expected economic growth rate into the analysis, providing a comprehensive understanding of the potential effects of policy interventions. It recognizes that the transition to a green economy can lead to job losses in certain sectors, particularly in industries that heavily rely on fossil fuels or contribute to environmental degradation. Furthermore, the study highlights the importance of addressing social and environmental concerns simultaneously.

4.2 Importance of the Study Settings

This study addresses the need to understand how various policy interventions might affect Bangladesh's economic and environmental sustainability. Using a Business-as-Usual (BAU) scenario as a baseline, which assumes no new interventions, it contrasts this with the implications of adopting a Steady State Green Growth (SSGD/SSD) vision by 2050. This vision includes policies focused on lowering carbon intensity and fostering sustainable economic growth. The study emphasizes the importance of adjusting key model parameters to ensure its predictions accurately represent Bangladesh's economic state as of 2020. By calibrating the Autonomous Energy Efficiency Improvement (AEEI) and Total Factor Productivity (TFP) rates, the study guarantees realistic forecasts for GDP and carbon intensity. Moreover, it highlights the significance of incorporating an average GDP growth rate for the fiscal year 2020 to fully grasp the impact of policy interventions. Adjusting the AEEI rate in line with the Bangladesh National Energy Policy facilitates an accurate portrayal of carbon intensity reduction efforts. Importantly, the study introduces a shadow environmental policy reform starting from 2025 to evaluate the effectiveness of policies aimed at carbon intensity reduction. By comparing the 'Exogenous shadow environmental policy reform' with 'Optimal Green Growth' development approaches, the study aims to shed light on the most effective strategies for achieving sustainable and green growth while ensuring national GDP remains intact.

4.3 Study Assessment

The assessment of the scenarios outlined in the report reveals critical insights into the trajectory of Bangladesh's economic and environmental future. The BAU scenario predicts steady economic growth but highlights a concerning trend of only marginal improvements in carbon intensity, signaling an urgent need for more aggressive environmental policies and a shift towards sustainable practices. In contrast, the SSGD/SSD vision adopts a comprehensive strategy that harmonizes economic development with environmental sustainability. This approach entails a significant reduction in the intensity of the economy's output, the promotion of sustainable practices across diverse sectors, and the adoption of robust environmental regulations alongside incentives for renewable energy and cleaner technologies. Such a strategy not only forecasts an economy moving towards sustainability, with declining carbon intensity against the backdrop of GDP growth, but also emphasizes the critical role of environmental policy reform in sustaining and enhancing these positive trends.

Moreover, the analysis prompts a deeper examination of the impact on sustainable industries, underscoring the importance of identifying the sectors witnessing job growth and their alignment with sustainable development goals. It calls for an evaluation of the social and welfare implications, including the distributional effects and the potential benefits of transitioning to a green economy, such as improved health outcomes and access to clean energy. The report suggests expanding on policy recommendations derived from the findings, focusing on measures that could facilitate the desired green growth outcomes. It highlights the significance of international cooperation and funding to support ambitious sustainability initiatives and stresses the need for assessing the long-term viability of these green growth strategies amid evolving technological, market, and policy landscapes. This comprehensive assessment illustrates the imperative for Bangladesh to navigate the complexities of transitioning to a green economy, ensuring that economic advancement does not come at the expense of environmental degradation and social inequality.

4.4 Long-term Challenges

The current environmental policy in Bangladesh may lack the necessary regulations and incentives to drive industries towards sustainable practices. While there might be some policies in place, they may not be effectively enforced or monitored, allowing industries to continue with business-as-usual practices that harm the environment. In addition, the lack of strict regulations and enforcement can also lead to non-compliance and a culture of non-accountability among industries. Without proper incentives and penalties for non-compliance, businesses may not feel compelled to invest in green technologies or practices, hindering the overall progress towards a green economy. Furthermore, there might be an absence of realization and appreciation between companies and consumers about the significance of green development. Some sectors may prioritize immediate economic gains over lifelong ecological stability. This partly due to the inexistence of awareness programs that stress the potential profits and opportunities of shifting towards a green economy.

Another factor that impacts the achievement of green growth in Bangladesh is the limited availability of financial resources. Adopting sustainable technologies and practices often requires upfront investments that may be financially burdensome for industries, especially small and medium-sized enterprises (SMEs). Without sufficient financial support from the government or access to affordable green financing options, SMEs may struggle to make the necessary investments in green technologies and infrastructure. Additionally, the lack of skilled manpower and expertise in green technologies can also impede the progress towards green growth. Creating a workforce that is educated enough in the field of environment and ecology that will espouse the transition from grey economy to green economy would require significant and dedicated investments in educational and training. Nonetheless, if the proper prerequisites in the shape of infrastructure and various other adjuncts or educational programs are not put in place, there may be an unavoidable dearth of proficient professionals having both technical skill and sustainable development expertise to an adequate level.

Expanding on the limited employment growth in green industries, it is important to understand the reasons behind this limitation. One possible reason is the lack of demand for green products and services in the market. If consumers are not actively seeking out environmentally friendly products or if there is a lack of awareness about the benefits of such products, it becomes difficult for green industries to thrive and expand. Factors that contribute to the limited employment growth in green industries is the lack of skilled manpower. Despite an increase in the need for environmentally friendly goods and services, there may not be enough individuals who have the right knowledge and abilities to meet this demand. There is a scarcity of professionals who know how to make products or run businesses in ways that are productive but do not cost the environment. This problem exists because education and training programs have not yet developed obvious pathways with technology.

Financial constraints faced by businesses also play a role in limiting employment growth in green industries. Adopting green technologies and practices often requires significant upfront investments, which can be financially burdensome for industries, particularly small and medium-sized enterprises. Without access to affordable green financing options or government support, businesses may be hesitant to invest in green initiatives and, as a result, may not be able to create new job opportunities. Shifting to a sustainable economy may necessitate the gradual elimination of specific businesses that are detrimental to the environment. This might prompt layoffs among various professions, such as those in the natural gas extraction and production industries. Even though the neatest strategy ideally would be to find replacements for these jobs in other occupations, guiding the affected workers on how to best navigate this transformation will be one of the hardest tasks society faces.

Moreover, the net export trend in Bangladesh is showing a somewhat declining pattern. This implies that the country's imports will be increasing at a higher rate than its exports over time. This could be due to the lack of focus on raw material for finishing local products and services in international markets, resulting in an imbalance between import and export volumes. There are several factors contributing to the declining trend in net exports in Bangladesh. One possible reason is the country's heavy reliance on imports for raw materials and intermediate goods. Bangladesh boasts a robust textile and garment sector, but one heavily reliant on foreign inputs like cotton and synthetic fibers, leaving it struggling with higher production costs and a global marketplace unable to fully embrace what it has to offer.

Another factor is the lack of diversification in the country's export basket. Bangladesh is primarily known for its ready-made garments and textile products, which account for a significant portion of its exports. However, relying heavily on a single industry makes the country vulnerable to changes in global demand and competition from other low-cost manufacturing countries. This lack of diversification limits the country's ability to capture market opportunities in other sectors and expand its export base. Furthermore, the country's limited value addition in its exports is also a contributing factor. In many cases, Bangladesh exports raw or semi-processed materials instead of finished products. This decreases the value of the exports and limits the potential for higher earnings. Additionally, inadequate investment in research and development and innovation also hampers the development of higher value-added products. While the country produces high-quality goods, there is often a lack of awareness and recognition about the origin and quality of these products. Their competitiveness is hampered when they are unable to command higher prices in the international marketplace. Additionally, the removal of quota-based exports after 2030, trade barriers, and the implementation of protectionist policies in certain countries could all stand in the way of Bangladesh's hopes for robust growth in exports. The inclusion of non-tariff barriers only serves to exacerbate the difficulties, with technical barriers to trade, as well as sanitary and phytosanitary measures, ending up as an unfortunate reality for Bangladeshi exporters. What's more, there's the significant issue of the increased cost of compliance, bolstered by the decreased market access, as Bangladeshi products work to find their footing within the sea of international competition.

4.5 Strategy and Solution Linkage

The Bangladesh Green Industries Diagnostic report critically evaluates the country's underperformance in green growth and sustainable development, identifying key areas for improvement. It highlights the nation's economic growth's slow pace in green sectors compared to others, persistent high exclusion despite recent policies, and the necessity to broaden inclusion across the economy. Strategy and solution linkage is the process of connecting an organization's strategic direction with the appropriate solutions or initiatives to tackle specific challenges or opportunities. This involves aligning the organization's goals and objectives with the most suitable actions and resources needed to achieve them. The purpose of strategy and solution linkage is to ensure that the chosen solutions and initiatives are in line with the overall strategic direction of the organization, allowing for efficient allocation of resources and focused efforts that contribute to the organization's long-term vision. Once a clear strategy is in place, the next step is to analyze the relationship matrix or connections between industries to pinpoint the key areas that require immediate attention or intervention as addressed in Figure 12.

Figure 12 provides information on the backward and forward linkages among various industries. The values show that different sectors have varying degrees of dependency on inputs from other sectors (backward linkages) and the extent to which their outputs are used as inputs by other sectors (forward linkages). For example, the agriculture, forestry, and fishery sectors have a relatively low dependency on inputs from other sectors (backward linkage of 0.23), but its outputs are extensively used by other sectors (forward linkage of 0.91). On the other hand, the textiles and wearing apparel sector heavily relies on inputs from other sectors (backward linkage of 0.64) but its outputs are not extensively used by other sectors (forward linkage of 0.61). The energy-intensive manufacturing sectors have a low forward linkage (0.17), suggesting that their outputs are not extensively used by other non-energy intensive sectors. These linkage measures highlight the interdependence and interconnectedness among different sectors of the economy. Sectors with high backward linkages are more dependent on inputs from other sectors, while sectors with high forward linkages play a crucial role in providing inputs to other sectors. The outcomes also include information on sectors such as petroleum products, energy-intensive manufacturing, coal products, fossil fuels-oil, transport, gas supply, electricity (nuclear and renewable), electricity (others), construction, and services. These sectors exhibit varying degrees of backward and forward linkages, indicating their interdependence with other sectors in the economy and those are important for fund allocation, identifying key sectors, efficient allocation of resources and focused efforts that contribute to polymers' decision process.

It is obvious from the study outcomes that the gas supply sector has a moderate reliance on inputs from other sectors, with a moderate backward linkage. Its outputs are used to a lesser extent as inputs by other sectors, as indicated by its lower forward linkage. The electricity (nuclear and renewable) sector has a minimal reliance on inputs from other sectors, with a very low backward linkage. Its outputs are used to a very low extent as inputs by other sectors, as indicated by its very low forward linkage. The electricity (others) sector heavily relies on inputs from other sectors, with a high backward linkage. Its outputs are extensively used as inputs by other sectors, as indicated by its high forward linkage. The construction sector has a higher reliance on input from other sectors, with a relatively high backward linkage. Its outputs are used to a moderate extent as inputs by other sectors, as indicated by its forward linkage. The services sector has a higher reliance on input from other sectors, with a relatively high backward linkage. Its outputs are extensively used as inputs by other sectors, as indicated by its high forward linkage[19]. These linkages play a crucial role in understanding how sectors interact and contribute to overall economic activity and long-term policy choice and strategy.

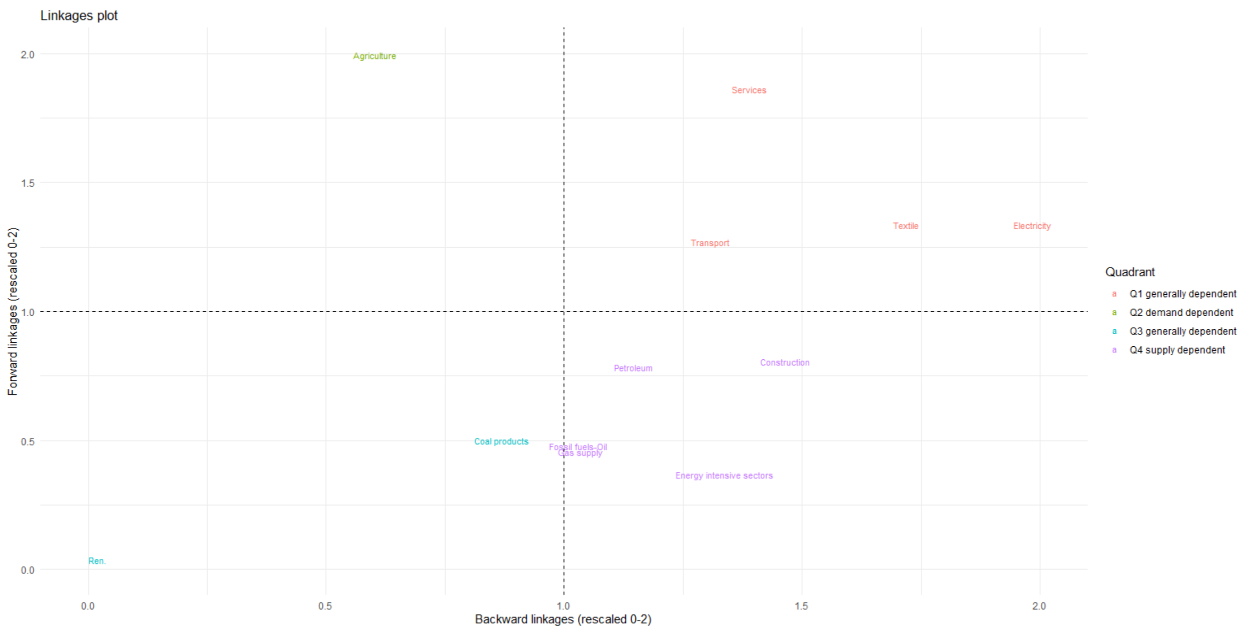

Figure 12. Correlation Matrix (/Backward and Forward Linkages)

Policymakers preserve this information to identify interdependencies between industries and anticipate the potential impacts of policies or disruptions in one sector on other sectors. It can help them make informed decisions regarding economic development strategies and allocate resources effectively. This knowledge can guide further research and analysis, providing a better understanding of the overall economic structure and dynamics. Thus, it is important to emphasize the vital need for innovative strategies and tools to fully leverage Bangladesh's resources and potential for sustainable growth, focusing on overcoming obstacles such as declining state capacity and spatial exclusion. By addressing the dual challenges of economic underperformance in green sectors and sector's environmental impact, the report outlines a path of regulatory frameworks for Bangladesh to enhance its green growth and sustainable development efforts. This strategic pivot aims not only to reduce carbon intensity within the country but also to position Bangladesh as a participant in reducing global carbon intensity, thereby contributing to the achievement of green growth by 2050 and beyond, while also addressing the pervasive issues of exclusion and disparity.

4.6 Policy Recommendations

Considering the analysis, the following policy suggestions are recommended to further promote green growth and sustainable development in Bangladesh.

[19] Overall, the backward and forward linkages of different sectors reflect their interconnectedness within the economy. Sectors that have higher backward linkages rely more on inputs from other sectors, while sectors with higher forward linkages have their outputs extensively used as inputs by other sectors.

4.6.1 Strengthen Regulatory Frameworks

There is a need for robust regulatory frameworks in Bangladesh aimed at decisively reducing carbon emissions through the establishment of stringent industry standards, consistent monitoring, reporting structures, and penalties for non-compliance. Such enhancements, coupled with international collaborations, are pivotal for Bangladesh's progress in diminishing carbon footprints and fostering green growth. These initiatives are expected not just to safeguard the environment but also to lay the foundation for a sustainable, flourishing future for the populace across generations. Moreover, regulatory measures should motivate the adoption of eco-friendly technologies and practices by offering incentives and subsidies to industries engaging in renewable energy ventures like solar and wind power, thereby reducing carbon emissions and endorsing sustainable economic progress.

Investing in renewable energy sources is crucial for Bangladesh to decrease its dependency on fossil fuels and, subsequently, its carbon emissions. Such an approach, alongside the promotion of energy efficiency across various sectors, is instrumental in emission reduction efforts. The government's role is significant in incentivizing energy-efficient technologies and practices through financial incentives, educational campaigns, and support for energy audits to pinpoint improvement areas. Additionally, collaboration with financial institutions to create accessible financing models for energy-efficient investments and capacity building within the energy sector is vital. Engaging with international partners for funding and expertise further strengthens Bangladesh's capacity to embrace sustainable and low-carbon pathways, underscoring the importance of global cooperation in the transition towards green growth and carbon emission reduction.

4.6.2 Invest in Renewable Energy

To reduce the reliance on fossil fuels and mitigate carbon emissions, there should be an increased focus on investing in renewable energy sources such as solar, wind, and hydroelectric power. This can be done through incentives for renewable energy projects, favorable regulatory frameworks, and financial support for research and development in clean energy technologies. International partnerships can play a key role in this transition. Developed nations that have significant expertise and resources in renewable energy can provide technical assistance and financial support to Bangladesh to develop its renewable energy sector. These partnerships can facilitate the transfer of technology, knowledge, and best practices, enabling Bangladesh to leapfrog traditional energy sources and adopt cleaner, more sustainable alternatives. Furthermore, collaborations with global organizations such as the United Nations Framework Convention on Climate Change (UNFCCC), the Green Climate Fund (GCF), and the World Bank can help Bangladesh access additional financial resources to support its climate change adaptation and mitigation efforts. These organizations offer funding for projects aimed at building climate resilience, promoting renewable energy, and reducing emissions. By actively engaging with these organizations, Bangladesh can tap into their expertise and funding mechanisms to implement effective low-carbon pathways and strategies.

International partnerships can also assist Bangladesh in capacity building and infrastructure development. Developed countries can provide technical expertise and support in building climate-resilient infrastructure. Additionally, collaboration with international organizations can help establish training programs and knowledge exchange platforms, enabling Bangladesh to build the skills and knowledge needed to address low-carbon pathways effectively and to address the playback time of renewable investment return. Collaboration with the international community goes beyond financial and technical support. It also includes advocacy and diplomacy efforts in global low-carbon pathways negotiations. By actively participating in international forums, Bangladesh can raise its concerns and priorities, ensuring its unique challenges and vulnerabilities are considered when developing global low-carbon pathways policies and agreements.

4.6.3 Policy Mapping of the Energy Sector

Bangladesh's energy sector plays a crucial role in the country's economic development, but it also contributes to environmental degradation using fossil fuels. The country's infrastructure is inadequate to meet growing energy demand, resulting in an imbalance between supply and demand. The heavy reliance on natural gas and other polluting energy sources poses a significant challenge to promoting green growth[20]. To effectively transition towards green energy, it is essential to incorporate technological advancements and innovation into policy frameworks. This requires understanding the specific needs of each sector and developing new approaches for providing energy services. In many cases, integrating renewable energy solutions into the existing energy network is the most practical and viable option. Creating a stable supply often requires the collaboration of multiple renewable energy sources. However, to gain market confidence in these new technologies, policy support is crucial, particularly in the early stages. Policies such as regulations, labelling, and carbon pricing can promote the widespread adoption of clean technologies.

Consistency in policy is a key factor in successfully achieving green growth in the energy sector. Bangladesh has shown leadership in promoting renewable energy through initiatives such as the Solar Homes System program implemented by IDCOL. This program, which combines microfinance and off-grid solutions, has demonstrated the potential for renewable energy adoption in the country. The government's efforts to create a diverse mix of energy sources, including some environmentally friendly options, are commendable. However, there are concerns that the government's simultaneous focus on coal-powered plants may not align with the long-term objective of green growth. Bangladesh has also considered implementing a carbon tax as a means of incentivizing low-carbon practices. While a "green tax" for pollution has been enacted, carbon pricing is still being developed. Achieving a green energy industry in Bangladesh requires a long-term commitment to transformation. The country has taken significant steps in laying the foundations for green energy, but these efforts need to be further enhanced and expanded upon. This includes scaling up renewable energy initiatives, ensuring policy consistency, and addressing potential conflicts between different energy sources. Overall, Bangladesh has made progress in promoting green growth in the energy sector, but continuous efforts are needed to realize the full potential of renewable energy (Washim Akram et al., 2022).

4.6.4 Promote Sustainable Agriculture

As the agricultural sector is a significant contributor to greenhouse gas emissions in Bangladesh, there is a need to promote sustainable agricultural practices. This includes supporting farmers in adopting climate-smart techniques, such as organic farming, agroforestry, and efficient irrigation systems. Additionally, there should be efforts to reduce post-harvest losses and promote value addition to agricultural products to increase their market value. Agriculture, on a global scale, confronts significant obstacles when it comes to adopting a strategy for sustainable growth. The projected increase in the need for food and agricultural resources due to population growth and higher incomes will put a strain on already limited natural resources, such as land and water. Agricultural producers must continuously

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[20] In terms of power generation, the primary source of energy in Bangladesh is natural gas, making up 56.06% of the supply. Biofuels and waste account for 24.65%, while oil contributes 16.39% and coal is responsible for 2.81%. Renewable energy sources have a very small share of only 0.1%. The country heavily relies on natural gas, and this dependence is projected to continue soon. However, there are ongoing plans to establish a nuclear plant that will be operational by 2020, and there has been progress in the construction of coal-based power plants in Rampal and Chittagong ("Bangladesh Power Sector at a Glance" - Bangladesh Power Development Board (BPDB): Link: http://www.bpdb.gov.bd/powerData.htm).

find ways to increase productivity, minimize resource use, adopt environmentally friendly practices, and combat the effects of climate change. In Bangladesh, the government has made a commitment to pursue green growth in its national plans and strategies. However, it is unclear how much emphasis is placed on the agriculture sector in this commitment. The government should provide support to farmers of drip irrigation or other water-efficient technologies that can significantly reduce water waste and improve water use efficiency.

4.6.5 Encourage Sustainable Transport

The transport sector is a major contributor to carbon emissions. Promoting energy and sustainable transportation can also be another important aspect of impacts of carbon emissions and the importance of reducing them is crucial in the fight against climate change and reach vision 2041. Transportation is a major contributor to carbon emissions globally. In Bangladesh, the transportation sector is heavily reliant on fossil fuels, particularly diesel and petrol. To reduce carbon emissions in this sector, the government should prioritize investment in public transportation systems by clean energy sources. Additionally, promoting the use of electric vehicles and improving infrastructure for their charging stations can significantly reduce carbon emissions from the transportation sector. In addition to promoting clean transportation, the government can also focus on energy-efficient urban planning and development. Furthermore, the government can implement policies to encourage the use of biofuels. This can include incentivizing the use of biofuels produced from agricultural waste or promoting the use of hydrogen fuel cells in automobiles. Investing in research and development of alternative fuels can also lead to advances in sustainable and low-carbon transportation options.

4.6.6 Promote Green Finance

Access to finance is a critical factor in driving green growth. The government should work with financial institutions to create incentives for green investments, such as providing low-interest loans for sustainable projects and offering policy benefits for companies adopting green practices. Additionally, there should be efforts to develop innovative financing mechanisms, such as green bonds and crowdfunding, to support sustainable initiatives.

4.6.7 Strengthen State Capacity

There is a need to enhance the capacity of the state to effectively implement and enforce environmental regulations. This can be achieved through capacity-building programs for relevant government agencies, including training on monitoring and enforcement procedures. Additionally, measures should be taken to address corruption and ensure transparency in regulatory processes. The government should work with private sector entities to develop sustainable value chains that support environmentally friendly and socially responsible practices.

4.6.8 Support Informal Sector Enterprises

The informal sector plays a significant role in the Bangladeshi economy; therefore, efforts should be made to support informal sector enterprises in adopting more sustainable practices. This can be done through targeted capacity-building programs, financial incentives for adopting green technologies, and facilitating access to sustainable financing options.

4.6.9 Foster Public-Private Partnerships

Public-private partnerships can play a crucial role in promoting green growth and sustainability. The government should create an enabling environment for collaboration between the public and private sectors, including the establishment of platforms for knowledge sharing, joint research initiatives, and incentivizing private sector investment in sustainable development projects. The government should actively participate in international forums and initiatives related to sustainable agriculture, climate change, and biodiversity conservation. This can involve sharing best practices, learning from experiences of other countries, and accessing international funding and technical assistance. Furthermore, bilateral and multilateral partnerships can be established to promote the exchange of knowledge, technology transfer, and joint research and innovation.

4.6.10 Invest in Research and Development

To identify new industries and technologies that can contribute to green growth, there should be increased investment in research and development. This includes funding research projects focused on developing innovative solutions to sustainability challenges, and supporting collaborations between academia, industry, and government.

4.6.11 Strengthen Environmental Education and Awareness

Raising awareness about the importance of sustainability and environmental stewardship is vital for driving behavior change. The government should integrate environmental education into school curricula and promote awareness campaigns targeting individuals, businesses, and communities. This can include training programs, workshops, and public events focused on sustainable practices. Educational institutions should incorporate sustainability principles into their curricula and provide opportunities for students to engage in experiential learning related to green growth and sustainable development. Driving continuous improvement and ensuring transparency and accountability necessitates monitoring and evaluation of sustainability initiatives' effect. To track progress, a strong monitoring and evaluation framework should be built by the government. Implementation of these suggestions will need the dedication and partnership of a host of stakeholders—the government, private sector, and Civil Society Organizations (CSOs). Through a unified approach that concentrates on capacity building, industry regulation, technology development, and public awareness, Bangladesh can make massive strides towards green growth and sustainable development.

4.6.12 Implement Sector-Specific Strategies

Tailor policies and interventions to the specific needs and potentials of different sectors, such as textiles, agriculture, and construction, to maximize their contributions to green growth. This includes addressing sector-specific challenges and capitalizing on opportunities for sustainable development.

4.6.13 Promote Sustainable Urban Planning

Encourage the development of green infrastructure and sustainable urban planning practices to address issues related to unplanned urbanization and its environmental impact. This could involve green building standards, sustainable transportation systems, and the preservation of green spaces.

4.6.14 Enhance International Cooperation

Engage in international partnerships to access technical and financial support for green growth initiatives, share best practices, and participate in global efforts to address climate change and promote sustainability. To promote green growth in Bangladesh, it is essential to take a combined and collaborative approach, including strict environment regulations, investment in renewable energy, energy efficiency, increased funding of, and investment in green technology and green jobs. The strategy, aimed at achieving sustainable development in a comprehensive manner, requires the joint efforts of the government, the business community, and civil society. For implementation to be successful, effective governance, an inclusive and wide-ranging approach to creating policies, and continuous adjustment to new challenges and opportunities are needed. If Bangladesh commits itself to these paths, it will secure for itself a sustainable and inclusive society ready to stand up to future challenges. At the same time, it will seriously tread on the path of redefining economic growth in harmony with environmental and societal governance.

SECTION 5. CONCLUSION

Through a comprehensive analysis, this study examines the critical pathways for Bangladesh to embark on a sustainable, green growth trajectory while furthering its industrial capabilities in line with environmental sustainability and climate commitments. The study highlights the dichotomy between the Business as Usual (BAU) scenario of steady economic growth with minor improvements in carbon efficiency; and the more pro-active Steady State Green Growth (SSGD/SSD) vision which fuses economic development and environmental stewardship.

The analysis argues that a transition towards green industries is fundamentally a strategic imperative for Bangladesh in terms of continued economic growth, mitigating the environmental degradation being detected and to capitalize on the attractive economic opportunities and competitive advantages that green growth clearly has. As part of the SSGD/SSD scenario, the vision is to develop a prosperous Bangladesh that achieves its development goals, while achieving a declining carbon intensity, allowing it to be considered to be part of the "2tonnes Carbon Club" by 2050, hence contributing in a positive manner to global efforts in terms of tackling climate change. To realize this vision, the study suggests which policies must be introduced and the corresponding investments areas, as well as the international support required to support green growth in Bangladesh.

The results show that Bangladesh is at a critical crossroads — it can use its expanding industrial sector as an opportunity to achieve growth that is environmentally sustainable, equitable, and resilient. Although the country faces significant obstacles, including regulatory gaps, heavy reliance on fossil fuels, and a scarcity of eco-friendly technologies, it also shows potential in turning these challenges into opportunities for green industrialization.

Overall, this study shows how Bangladesh stands to benefit by pursuing green growth. Moving towards a low-carbon and sustainable industrial growth pathway is no longer a choice in responding to the global climate crisis, but is rather a challenge that could enable Bangladesh to position itself as the green growth leader in the region and beyond. The transition to green growth thus requires concerted efforts around policy reformulation, stakeholder engagement and international cooperation to achieve the vision of a sustainable and prosperous Bangladesh.

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APPENDIX

Table- A1: Macro Social Accoing Matrix (SAM) of Bangladesh (2020) *

	1	2	3	4	5	6	7	8	9	10	11	12	FD	FD	FD
	Agr	**Pet**	**Gar**	**Eis**	**Col**	**Oil**	**Trn**	**Gas**	**Ely_N**	**Ely**	**Con**	**Ser**	**Cons**	**Inv**	**Nx**
Agr	6,466.37	-	8,259.07	9,555.88	-	-	-	-	-	-	1,724.21	3,050.67	39,619.50	67.87	164.60
Pet	67.19	87.19	1,258.54	1,456.07	-	-	1,415.00	536.88	10.82	361.90	1,673.39	190.57	330.01	0.01	- 38.36
Gar	1,517.47	61.48	10,388.40	12,019.47	0.64	1.09	1,059.18	156.50	3.15	105.49	7,184.87	2,995.96	17,886.92	4,795.46	28,248.20
Eis	1,755.81	71.13	12,019.47	13,906.70	0.74	1.27	1,225.48	181.07	3.65	122.05	8,312.95	3,466.37	20,695.33	5,548.39	32,683.42
Col	1.76	0.15	4.63	5.35	-	-	6.47	0.43	-	0.29	2.85	0.94	2.64	0.03	7.41
Oil	3.00	0.26	7.88	9.12	-	0.04	11.02	0.72	-	0.49	4.86	1.60	4.50	0.05	12.62
Trn	1,028.68	55.42	2,973.40	3,440.34	0.82	1.39	844.76	209.03	4.21	140.90	2,786.02	1,747.46	30,337.17	7,099.94	360.58
Gas	173.92	77.81	831.72	962.30	1.50	2.55	417.01	36.71	0.74	24.74	687.06	81.60	2,018.93	61.97	- 131.22
Ely_N	3.50	1.57	16.76	19.39	0.03	0.05	8.40	0.74	-	0.50	13.85	1.64	40.69	1.25	- 2.64
Ely	117.24	52.45	560.63	648.66	1.01	1.72	281.09	24.74	0.50	16.68	463.12	55.01	1,360.89	41.77	- 88.45
Con	2,015.87	250.43	8,457.45	9,785.31	16.53	28.15	5,492.54	507.49	10.23	342.08	19,156.31	6,137.40	46,094.94	48,035.51	- 2,338.69
Ser	3,190.86	122.41	9,609.62	11,118.31	1.46	2.49	2,201.44	492.05	9.92	331.68	12,776.95	7,568.83	75,943.34	3,954.03	11,081.39
L	**13,403.97**	**1,678.89**	**7,754.86**	**8,972.44**	**1.87**	**3.19**	**9,486.37**	**774.80**	**15.61**	**522.27**	**22,386.55**	**28,840.34**	**234,334.86**	**69,606.29**	**69,958.85**
K	**38,149.75**	**4,778.41**	**22,071.53**	**25,536.95**	**5.34**	**9.09**	**26,999.66**	**2,205.19**	**44.44**	**1,486.45**	**63,715.58**	**82,084.04**			
Tax	**1,012.82**	**111.69**	**2,210.35**	**2,557.39**	**3.01**	**5.13**	**1,581.59**	**120.96**	**2.44**	**81.54**	**3,103.05**	**2,182.42**			
TOT	**68,908.20**	**7,349.30**	**86,424.29**	**99,993.69**	**32.97**	**56.17**	**51,030.02**	**5,247.33**	**105.71**	**3,537.05**	**143,991.59**	**138,404.84**			

* USD Billion

* Cons- National consumptions
Inv - National investments
Nx - Net exports

Table- A2: Net-exports of Bangladesh (**2017**) *

	EXP	IMP	NX
Agr	1,092.65	974.42	118.23
Pet	14.70	42.26	- 27.56
Gar	49,201.38	5,434.11	43,767.27
Eis	6.31	0.99	5.32
Col	10.75	1.68	9.07
Oil	1,130.95	871.95	259.00
Trn	12.96	107.22	- 94.26
Gas	0.26	2.16	- 1.90
Ely_N	8.74	72.27	- 63.53
Ely	357.41	2,037.30	- 1,679.89
Con	9,096.68	1,136.90	7,959.78
Ser	**60,932.78**	**10,681.25**	**50,251.53**

* USD Billion

Table -A3: Sectoral classification in SAM (2020)

Agr	Agriculture, forestry and fishery
Pet	Petroleum products
Gar	Textiles and textile products
Eis	Energy intensive manufacturing sectors
Col	Coal products
Oil	Fossil fuels-Oil
Trn	Transport
Gas	Gas supply
Ely_N	Electricity (nuclear)
Ely	Electricity (conventional)
Con	Construction
Ser	Services

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