REPORT

Reduction of Tax Incidence on Renewable Energy Equipment

Potential Implications for Bangladesh

FEBRUARY 2026

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Acknowledgement

This study was conducted by the South Asian Network on Economic Modeling (SANEM) in collaboration with the Tara Climate Foundation. We would like to express our sincere appreciation to Barun Deb Pal (Research Coordinator, IFPRI) for providing hands-on training in CGE modeling, which significantly supported the application of the CGE framework in this project. We are also grateful to Sk. Ashibur Rahman, Deputy Director (Admin) at SANEM, for managing internal and external communications and for providing logistical support throughout the study.

Published in February 2026

Citation: Raihan, S., Ahmed, M. T., Ahmed, S. T., Chakraborty, A., & Mubarrat, N. (2026). *Reduction of Tax Incidence on Renewable Energy Equipment: Potential Implications for Bangladesh.* SANEM Publications, Dhaka, Bangladesh.

Published by
South Asian Network on Economic Modeling (SANEM)
Flat K-5, House 1/B, Road 35, Gulshan 2
Dhaka 1212, Bangladesh
Phone: +88-02-58813075
Email: sanemnet@yahoo.com
http://www.sanemnet.org

With support from the Tara Climate Foundation.

Cover Design: Fahmida Farzana

Publisher
SANEM Publications
252/3, North Goran, Khilgaon
Dhaka-1219, Bangladesh

ISBN Number
978-984-29181-5-5

Table of Contents

List of Figures

List of Tables

Acronym and Abbreviation

ADB	*Asian Development Bank*
ADP	*Annual Development Program*
BEPZA	*Bangladesh Export Processing Zones Authority*
BEZA	*Bangladesh Economic Zones Authority*
BIDA	*Bangladesh Investment Development Authority*
BDT	*Bangladeshi Taka*
BPDB	*Bangladesh Power Development Board*
CBA	*Cost–Benefit Analysis*
CDM	*Clean Development Mechanism*
CGE	*Computable General Equilibrium*
CIT	*Corporate Income Tax*
CPI	*Consumer Price Index*
EEG	*Erneuerbare-Energien-Gesetz*
ETR	*Ecological Tax Reform*
EU	*European Union*
EV	*Electric Vehicle*
FDI	*Foreign Direct Investment*
FIT	*Feed-in Tariff*
FY	*Fiscal Year*
GBI	*Generation-Based Incentive*
GDP	*Gross Domestic Product*
GCF	*Green Climate Fund*
HS	*Harmonized System*
IDCOL	*Infrastructure Development Company Limited*
IEA	*International Energy Agency*
IEEFA	*Institute for Energy Economics and Financial Analysis*
IEPMP	*Integrated Energy and Power Master Plan*
IREDA	*Indian Renewable Energy Development Agency*
IRENA	*International Renewable Energy Agency*
ITC	*Investment Tax Credit*
LCOE	*Levelised Cost of Energy*
LNG	*Liquefied Natural Gas*
LOI	*Letter of Intent*
MAP	*Market Incentive Program*
MCF	*Marginal Cost of Public Funds*
MNRE	*Ministry of New and Renewable Energy*
MoPEMR	*Ministry of Power, Energy, and Mineral Resources*
MTEP	*Medium-Term Energy Price*
MW	*Megawatt*
NBR	*National Board of Revenue*
NEV	*New Energy Vehicle*
NSM	*National Solar Mission*
OECD	*Organization for Economic Co-operation and Development*
PTC	*Production Tax Credit*
PV	*Photovoltaic*
R&D	*Research and Development*
RE	*Renewable Energy*

REC	*Renewable Energy Certificate*
RPO	*Renewable Purchase Obligation*
RPS	*Renewable Portfolio Standard*
SAM	*Social Accounting Matrix*
SECI	*Solar Energy Corporation of India*
SIP	*Solar Irrigation Pump*
SREDA	*Sustainable and Renewable Energy Development Authority*
SRO	*Statutory Regulatory Order*
TGC	*Tradable Green Certificate*
TIB	*Transparency International Bangladesh*
TTI	*Total Tax Incidence*
UNCTAD	*United Nations Conference on Trade and Development*
USD	*United States Dollar*
VAT	*Value Added Tax*
VGF	*Viability Gap Funding*
VPP	*Virtual Power Plant*
WHO	*World Health Organization*

Executive Summary

Bangladesh stands at a critical juncture in its pursuit of energy security and sustainability. The country relies on imported fossil fuels for over 62.5% of its primary energy supply. This dependence creates a subsidy burden of nearly US$3.22 billion annually, exposes the macroeconomy to volatile global price shocks, and channels 96% of power sector investment into gas, coal, and LNG infrastructure. Renewable energy (RE) remains chronically underfunded and structurally marginalized. Against this backdrop, the government has set ambitious targets under the Renewable Energy Policy 2025: to source 20% of national electricity from renewable energy by 2030 and 30% by 2040. However, the fiscal regime for renewable energy equipment remains deeply contradictory. The Total Tax Incidence on essential components such as solar panels, inverters, batteries, and wind turbine parts ranges from 26% to 127%. In FY2025–26, 61% of the 74 renewable energy-related products identified in this study experienced tax increases rather than reductions. Bangladesh is, in effect, taxing its own energy transition.

This report investigates whether reducing or eliminating the Total Tax Incidence on renewable energy equipment is economically justified, fiscally sustainable, and socially beneficial for Bangladesh. It does so through three complementary lenses. First, an international comparative review examines renewable energy fiscal policies in India, China, and Germany. Second, a partial equilibrium cost–benefit analysis uses import demand elasticities for 13 selected renewable energy products. Third, an economy-wide Computable General Equilibrium (CGE) simulation draws on the 2022 Bangladesh Social Accounting Matrix. This matrix covers 86 production sectors, 13 factor categories, and 15 household groups.

Experiences from Country Case Studies

The experiences of India, China, and Germany, representing market-driven, state-led, and institutionally anchored transition paradigms, respectively, converge on a consistent finding. The most effective fiscal lever for accelerating renewable energy adoption is the strategic elimination of upfront cost barriers through tariff reductions, tax exemptions, and investment incentives. India's Investment Tax Credits and reverse-bidding auctions, China’s VAT exemptions and corporate income tax breaks, and Germany’s Renewable Energy Sources Act and feed-in tariff architecture all support this conclusion. When fiscal policy aligns with clean energy goals instead of working against them, deployment accelerates rapidly, costs fall, and both economic and environmental dividends follow. Bangladesh’s current fiscal approach, characterized by high and rising TTIs on renewable energy components, stands in direct contrast to this evidence.

Cost–Benefit Analysis of Tariff Reduction on RE Components: Evidence from a Partial Equilibrium Analysis

The elasticity-based analysis confirms that reducing the TTI to 0% generates gross revenue losses ranging from 22% to 44% of new revenue across the 13 products examined. However, demand elasticity substantially moderates the true net fiscal burden. For high-elasticity products such as lead-acid solar cells (elasticity of -0.909) and vapor-generating boilers (elasticity of -0.999), welfare gains of up to 25% offset a large share of the revenue loss. This reduces the net fiscal cost to as low as 5%. For lower-elasticity products such as gas burners and wind power equipment parts, net losses remain higher at 17–22%. This suggests the need for a differentiated, product-specific approach to TTI reform rather than a blanket reduction. Critically, these estimates capture only direct fiscal and consumer welfare effects. They exclude the broader macroeconomic, environmental, employment, and energy security benefits that constitute the full social return from the reform. All these broader benefits point in the same direction: benefits substantially exceed costs when assessed comprehensively.

Cost–Benefit Analysis of Tariff Reduction on RE Components: Evidence from an Economy-Wide Perspective

The CGE simulation of a 100% TTI reduction on all renewable energy components provides the most comprehensive and conclusive evidence in the study. On the cost side, import taxes as a share of GDP decline by 0.09 percentage points, and nominal government spending contracts by 0.11%. These are real fiscal costs, but are modest and partially offset by higher import volumes, broader economic expansion, and reduced pressure from fossil fuel subsidies. On the benefits side, the results are unambiguously positive across all dimensions. GDP expands by 0.04% from a base of BDT 42.31 billion. Exports increase by 0.47% from BDT 4.99 billion. The trade deficit as a share of GDP narrows by 0.04 percentage points. The Consumer Price Index falls by 0.02%. The Investment-to-GDP ratio improves. Real household income and consumption rise by 0.08% and 0.02%, respectively, from base values of BDT 31.47 billion and BDT 28.11 billion. The welfare gains are progressive. Rural farm households, rural nonfarm households, and low-income urban groups all benefit disproportionately through lower agricultural input costs, reduced consumer prices, and higher factor incomes. These static CGE results conservatively understate the long-run gains.

As the renewable energy transition deepens, savings from reduced fossil fuel subsidy expenditure, now estimated at US$3.22 billion annually, will surpass the near-term tariff revenue foregone.

Policy Recommendations

The report advances a comprehensive, three-tier set of policy recommendations. The first tier, grounded in the existing policy landscape, calls for a unified TTI reduction strategy across all renewable energy technology categories. It also urges targeted fiscal support for solar irrigation pumps and electric vehicles, fast-tracking of stalled renewable energy projects under SREDA, and expansion of Bangladesh Bank's green refinancing scheme. Additional recommendations include developing a sovereign green bond market and establishing formal inter-ministerial coordination to ensure policy consistency and investor confidence.

The second tier, derived from the partial equilibrium analysis, recommends that the NBR immediately prioritize TTI reductions for high-elasticity products, where the welfare gains are largest relative to the fiscal cost. Authorities should adopt a phased 5% TTI floor for moderate-elasticity products with a clear roadmap to full elimination. Other recommendations include complementing tariff reductions with investment tax credits, production-linked incentives, and direct consumer rebates. Finally, a biennial TTI review mechanism based on transparent elasticity and welfare data should become institutionalized.

The third tier, grounded in CGE results, advises the government to position TTI elimination as a macroeconomic growth policy rather than just an environmental commitment. The short-term revenue transition should be financed through phased rationalization of fossil fuel subsidies. The depreciation of the exchange rate induced by reform can be leveraged to boost export competitiveness. Protection and expansion of household welfare gains should occur through targeted measures for rural and low-income groups. A National Energy Transition Fund, funded by subsidy savings, green bonds, and international climate finance, should be established. The annual budget cycle should align with renewable energy targets by mandating a minimum renewable energy share of the energy sector's Annual Development Program.

The evidence presented in this report is unambiguous. The short-term fiscal cost of eliminating the Total Tax Incidence on renewable energy equipment in Bangladesh is real but bounded, manageable, and substantially offset by immediate economy-wide gains. The long-term benefits, spanning macroeconomic growth, export competitiveness, household welfare, energy security, and environmental sustainability, are multidimensional, durable, and self-reinforcing. Every year that Bangladesh maintains a high tax burden on components of its own energy transition is a year of foregone growth, preventable inflation, avoidable subsidy expenditure, and compounding vulnerability to global fossil-fuel price shocks. The case for reform is not simply strong; it is, on the evidence, overwhelming.

1. Introduction

1.1 Background

As Bangladesh strives to achieve a US$1 trillion economy by 2034, its energy security has emerged as its greatest vulnerability. The country relies heavily on fossil fuel imports to generate power as a cost-effective solution to its energy issues. The nation's reliance on imported fossil fuels has exposed the economy to volatile global price fluctuations, leading to a subsidy burden of nearly US$3.22 billion in recent years (IEEFA, 2024). This introduction explores how the current energy framework, long anchored in fossil fuels, is being dismantled in favor of a decentralized, renewable-heavy model. The Integrated Energy and Power Master Plan (IEPMP) 2023 and the Renewable Energy Policy 2025 now mandate that 20% of total electricity must come from renewable sources by 2030 (MoPEMR, 2025a).

However, this dependence poses long-term sustainability risks and exposes the country to fluctuations in global energy prices (Raihan et al., 2026; Raihan et al., 2025a). Amid these challenges, there is growing recognition that reducing the tax burden on renewable energy components is crucial to accelerating the transition to clean energy in Bangladesh. By reducing upfront costs, these tax measures would improve accessibility, reduce reliance on fossil fuels, and support Bangladesh's climate commitments. Such measures could also stimulate domestic renewable energy industries and generate economic, social, and environmental benefits. Bangladesh has taken the initiative to diversify its energy mix by investing in renewable energy sources, such as solar, wind, and biomass, to address these challenges. Despite noteworthy progress in solar home systems and grid-connected solar projects, the expansion of the renewable energy sector is still constrained by high upfront costs and limited policy support (Raihan et al., 2025c). To bridge the investment gap required to meet these 2030 targets, the state has moved beyond tariff cuts to offer long-term institutional support (IEEFA, 2024). Through SRO No. 400-Law/Income Tax-54/2024, the government has established a 15-year phased tax holiday for renewable energy producers. This includes a 100% income tax exemption for the first 10 years of operations for plants commencing commercial production by 2030 (UNCTAD, 2024).

A high tax burden on essential components such as solar panels, inverters, batteries, and wind turbines is a major obstacle to the widespread adoption of renewable energy (Raihan et al., 2024b). VAT, customs duties, and other levies largely increase the cost of these products, making renewable energy less competitive with conventional sources. Historically, the expansion of the renewable energy sector in Bangladesh was stifled by a fiscal contradiction. While the government established clean energy targets, the actual "tax incidence" on essential components acted as a major deterrent. According to the National Board of Revenue (NBR), cumulative taxes, including customs duties, regulatory duties, and VAT on solar panels and inverters, ranged from 26% to 127% when supplementary levies were accounted for (NBR, 2025). This creates disincentives for businesses and individuals who wish to adopt clean energy solutions. This high entry cost made solar and wind projects significantly less competitive than fossil-fuel-based power, which benefited from long-term subsidies and lower upfront capital requirements. Research by Transparency International Bangladesh (TIB) indicates that this "strategic priority" of fossil fuels resulted in nearly 96% of the power sector’s investment being funneled into gas, coal, and LNG projects, with only 3.3% of foreign investment in the power sector directed toward renewable energy (TIB, 2025).

In response to a mounting energy crisis and the high cost of imported LNG, the Government of Bangladesh enacted a series of radical fiscal reforms in the FY2025–26 National Budget. The National Board of Revenue (NBR) slashed the import duty on solar panels and inverters from 37% and 10%, respectively, to a symbolic 1% (Islam, 2025). This reduction is projected to lower the Levelized Cost of Energy (LCOE) for solar projects by approximately 20%, suddenly making clean energy a viable alternative for the country's industrial heartland (Bangladesh Solar News, 2025).

This study aims to investigate the potential benefits and implications of lowering VAT, taxes, and customs duties on renewable energy equipment in Bangladesh. The objective is to provide policymakers with a comprehensive cost–benefit analysis that balances the long-term economic, environmental, and social gains from increasing renewable energy adoption with the short-term budgetary benefits of tax reductions. By leveraging advanced modeling methodologies and engaging key stakeholders, the study aims to offer actionable policy recommendations to advance the nation's energy transition toward a sustainable energy future.

1.2 Objective of the Study

The objective of this study is to examine whether reducing existing VAT, taxes, and customs duties on renewable energy equipment can accelerate the adoption of renewable energy in Bangladesh. Specifically, the study aims to assess how tax reductions can lower the cost of renewable energy technologies and facilitate a transition away from gas- and LNG-based power generation toward cleaner, more sustainable, and cost-effective energy sources. By focusing on the fiscal dimension of renewable energy policy, the study seeks to generate evidence-based insights to support policy decisions that promote renewable energy development in Bangladesh.

1.3 Report Structure

The rest of the report is structured as follows. Chapter 2 reviews the existing literature on renewable energy taxation and fiscal incentives, emphasizing their economic and environmental impacts. Chapter 3 examines Bangladesh's existing policy guidelines and explores potential fiscal incentive scopes for renewable energy. Chapter 4 illustrates case studies of India, China, and Germany, analyzing their renewable energy taxation policies and outcomes. Chapter 5 conducts a cost–benefit analysis of tax reductions on renewable energy components using a partial equilibrium framework. Chapter 6 conducts another cost–benefit analysis of tax reductions on renewable energy components from an economy-wide perspective. Chapter 7 concludes the report with key findings and policy recommendations for relevant stakeholders.

2. Review of Literature

Fiscal policies, tax incentives, and targeted subsidies have played a central role in accelerating renewable energy adoption worldwide. Evidence from both developed and developing countries demonstrates that strategic use of these tools can reduce costs, stimulate market growth, and promote technological innovation in renewable energy sectors (Wang & Shao, 2014; Anika et al., 2025). Successful renewable energy transitions in countries such as the United States, Germany, and Japan highlight how combinations of fiscal and financing measures can drive adoption, create employment, and support technological advancement (Wang & Shao, 2014).

In the United States, fiscal tools such as tax credits, subsidies, grants, and low-interest loans have played a key role in lowering renewable energy costs and driving market growth. Major initiatives include the Investment Tax Credit (ITC) and Production Tax Credit (PTC) for wind, solar, and biofuel projects, alongside USD 150 billion in R&D funding in 2009. Federal mandates requiring 7.5% of electricity generation from renewable sources reinforced these efforts. Measures such as accelerated depreciation encouraged private investment, and the Energy Tax Act and the Recovery Act (2009) helped reduce costs, expand adoption, and boost clean energy innovation (Wang & Shao, 2014). Empirical evidence shows that subsidies, particularly tax credits and direct financial incentives, have significantly accelerated renewable energy deployment. The federal ITC mobilized private investment in solar projects, generating employment opportunities and supporting workforce transition programs that retrain displaced coal workers (Adelekan et al., 2024). Complementary research by Buonocore et al. (2016) shows that, in the U.S., the health and climate benefits of energy efficiency and renewable energy technologies vary by technology and location. The greatest benefits occur when these technologies replace coal-based electricity, which emits much higher levels of greenhouse gases than natural gas. Bolinger (2014) highlights the role of tax incentives in reducing project costs, as the benefits for sponsors depend on how the incentives are implemented and on the policy framework.

Similarly, Germany's renewable energy leadership has been supported by strong fiscal policies, including over EUR 6 billion annually in R&D funding, feed-in tariffs guaranteeing fixed energy prices, and targeted subsidies of up to EUR 60,800 per wind turbine. The Renewable Energy Sources Act (EEG) ensures market stability with production subsidies (EUR 0.091/kWh for wind) that gradually phase out as technologies mature. Complementary programs such as the 100,000 Solar Roofs, low-interest loan scheme, and the EUR 50 billion green stimulus package in 2009 for electric vehicles and batteries have helped establish Germany as a global leader in wind and solar energy deployment (Wang & Shao, 2014).

Japan presents another successful case, with renewable energy expansion driven by R&D investment (JPY 57 billion annually through the New Sunshine Plan), direct subsidies covering up to 50% of project costs, and household solar incentives that increased installations fivefold between 1994 and 2008. Combined with tax breaks for private investors, these measures reduced solar system costs by 77% and stimulated market growth and technological advancement (Wang & Shao, 2014). Huang and Kim (2021) found that capital-use subsidies substantially increased the share of solar, wind, and geothermal power, where solar experienced the largest growth. These incentives lowered the prices of renewable energy output and improved cost-effectiveness when integrated with virtual power plant (VPP) technologies. Melnyk et al. (2021) also showed that government incentives, subsidies, and commercialization schemes stimulated investment in both concentrated and distributed power plants.

Across Europe, tax incentives have facilitated investment in wind, solar, and biomass technologies. Production and investment tax credits, VAT, and property tax reductions and guaranteed tariffs have lowered the cost of capital-intensive projects, fostered corporate R&D, and increased market adoption of new technologies. Germany and Denmark have successfully used feed-in tariffs and low-interest loans to advance renewable energy, while Denmark, Finland, and Sweden have extensively used tax incentives. OECD data revealed that Denmark dedicates around 0.25% of its GDP (0.7–0.77% of tax revenues) to renewable energy incentives, primarily through income tax breaks for wind, solar, hydro, and geothermal projects. Finland and Sweden lead in energy efficiency, allocating 0.3% of GDP (1.41–1.58% of tax revenues) and 0.16–0.25% of GDP (0.68–1.1% of tax revenues), respectively, both above the OECD average (Tiwari et al., 2024; Tyurina et al., 2023).

These policies have translated into significant economic benefits across the EU. Between 1998 and 2008, the EU gained a total net benefit of about EUR 47 billion from renewable energy use, averaging EUR 8 billion per year, with the peak reaching EUR 72 billion in 2008. Countries with higher shares of renewable energy experienced smaller electricity price increases during periods of high oil prices. In contrast, countries with lower shares of renewable energy experienced larger price hikes, highlighting renewable energy's role in stabilizing costs (Krozer, 2013). Targeted fiscal and tax policies across EU countries have further supported investment. The Czech Republic, France, Belgium, Spain, and Italy use income, corporate, or property tax reductions; Germany, Denmark, Sweden, Poland, and Romania provide excise duty exemptions; France, Italy, and Portugal apply reduced VAT on renewable equipment; and the UK uses a Pigouvian tax (the Climate Change Levy) with exemptions for renewable energy sources (Cansino et al., 2010). These measures not only reduced reliance on fossil fuels and CO_2 emissions but also generated a double dividend of environmental and economic benefits through job creation. Community energy initiatives also played an important role by enabling citizens to produce and manage renewable energy while generating collective local benefits. Members of such initiatives across EU countries valued environmental outcomes more than financial gains, and positive environmental impact emerged as the most important perceived benefit (Soeiro & Ferreira Dias, 2020).

In contrast, countries such as Russia offered limited tax incentives, which constrained innovation and slowed the growth of alternative energy and energy-efficient engineering (Ogunlana & Goryunova, 2017). Similarly, Ebaidalla (2024) analyzed data from 37 major renewable energy-producing countries between 1996 and 2021 and concluded that taxation discourages renewable energy investment, whereas technological innovation and open trade stimulate growth. However, the study also showed that rising tax revenues can weaken the positive effects of innovation and trade, suggesting that tax reforms could maximize investment outcomes.

Among Asian countries, China provides a prominent example of how large-scale fiscal subsidies and tax incentives can accelerate renewable energy deployment while generating environmental and employment benefits. China invested CNY 33,448.84 million in renewable energy subsidies between 2006 and 2011, distributed equally across wind, biomass, and solar PV. The number of renewable energy projects increased from 38 to 806 during this period, which fueled rapid growth in both installed capacity and on-grid generation. These subsidies generated environmental benefits valued at CNY 17.88 billion by reducing emissions of CO_2, SO_2, NOx, CO, TSP, dust, and residue. Technological progress in wind, solar PV, and biomass has improved efficiency and narrowed the cost gap with conventional power. These subsidies fueled investment in wind and solar PV, supported related manufacturing, and created employment in the economy (Zhao et al., 2014). Mu et al. (2018) found that expanding wind power and solar PV generate positive direct and indirect jobs across all life-cycle stages. Solar PV creates more jobs during capacity investment, and wind power supports more maintenance-related employment. Net employment effects are highly sensitive to financing: electricity consumption fees can reduce overall jobs due to higher costs and lower sectoral activity, whereas lump-sum taxes largely offset these effects. The analysis suggested that solar PV can generate more jobs in certain scenarios, but wind power can provide more stable employment. China has also promoted renewable energy through fiscal and tax incentives, including preferential VAT rates, reduced corporate income tax, and reduced import duties, thereby lowering operational costs and encouraging investment. The government clarified exemption conditions for wind power equipment to support domestic R&D and reduce dependence on imports (Zhao et al., 2016).

Evidence from 36 developing countries suggests that renewable energy consumption significantly reduces CO_2 emissions, whereas environmental taxes alone are less effective. This shows the greater impact of subsidies and incentives compared to taxation in advancing renewable energy transitions in developing contexts (Rabhi et al., 2024). Evidence from Asia also illustrates this dynamic. A study assessing six fiscal incentives in Indonesia's renewable energy sector found that tax measures, such as tax holidays and allowances, were more effective than subsidies in reducing electricity prices, with solar PV proving more responsive than wind (Halimatussadiah et al., 2023). Moreover, Nawawi et al. (2022) found that solar PV adoption generated substantial local benefits. It resulted in an 18.07% reduction in household electricity costs, a 54.44% improvement in energy efficiency, and a 69.56% decrease in CO_2 emissions in Indonesia. These outcomes emphasize the potential of solar energy to reduce reliance on subsidies, lower household expenditures, and promote sustainable growth in the green energy sector.

Other developing countries have also benefited from targeted fiscal and financing mechanisms. In Chile, a combined policy package of a carbon tax, a coal phase-out, and subsidies for non-conventional renewable energy achieved emission reductions of 40–57% (Mardones, 2024). Nassar et al. (2019) analyzed the Egyptian power system under three renewable power generation (RPG) scenarios ranging from 2% to 22%. Higher RPG levels reduced reliance on conventional fuels, saving up to 1,773.86 ktoe of oil and cutting CO_2 emissions by over 53 million tons in the most ambitious scenario. Economic benefits included state savings of up to USD 749 million through reduced fuel consumption and lower CO_2 capture costs. The study estimated that renewable energy would save 19,066 ktoe of fuel and reduce CO_2 emissions by 46.4 million tons, generating financial returns exceeding USD 433 million while supporting significant environmental improvements by 2022.

Vietnam has supported renewable energy development through comprehensive fiscal incentives, including corporate tax exemptions and reductions, land-use tax waivers, fast depreciation for renewable projects, and import tariff exemptions for unavailable equipment and raw materials (Nguyen et al., 2021). Solar feed-in tariffs (FITs), introduced in 2017, drove rapid growth in solar PV installations, while wind FITs were less effective due to higher costs and shorter eligibility periods. Additional support, such as corporate income tax exemptions, import tariff exemptions, and land lease concessions, helped to reduce financial barriers (Do et al., 2021). Small hydropower projects benefited from initiatives like the Avoided Cost Tariff, standardized power purchase agreements, and CDM support, although assessing their full effectiveness is challenging due to limited transparency and associated administrative and social costs (Khanh et al., 2012). Solar PV and micro-hydro installations became effective in Nepal after the government implemented a renewable energy subsidy policy (Gurung et al., 2012). Zahedi (2011) highlighted that distributed generation from solar and wind can improve power reliability, reduce costs, and deliver environmental and social benefits. Chatri et al. (2018) found that reducing natural gas subsidies negatively impacted GDP, employment, and household welfare in Malaysia. However, redirecting savings to subsidize renewable energy increased output and offset macroeconomic losses. Feed-in tariffs were more effective when combined with revenue recycling, while reducing natural gas subsidies lowered overall CO_2 emissions. At the same time, coal-related emissions rose slightly due to substitution effects.

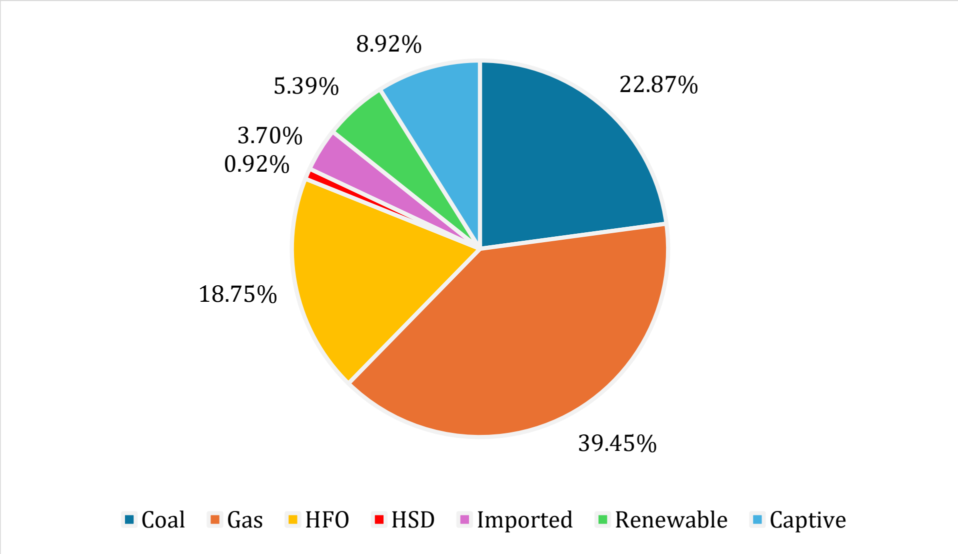
Financing mechanisms, trade policies, and technology adoption also significantly affect renewable energy deployment. Jha (2013) found that import tariff liberalization boosts production, employment, and trade in wind energy equipment, particularly in countries with a comparative advantage, such as China, Japan, Korea, and Taiwan. In contrast, removing fossil-fuel subsidies significantly reduces carbon emissions in coal-dependent economies. However, it can also lead to welfare and GDP losses and sharp increases in electricity prices, as seen in India and South Africa. Advancing sustainable energy technologies (SET) is critical for achieving carbon neutrality and mitigating climate change. Using a CGE analysis, Gao et al. (2024) found that SET can reduce electricity costs, lower fossil fuel consumption, and improve both industrial and energy structures. Newer renewable sources such as wind and solar offer strong benefits compared with traditional energy sources.

Collectively, the literature highlights that a combination of fiscal incentives, financing mechanisms, and supportive policy frameworks is critical for accelerating renewable energy adoption. Both developed and developing countries demonstrate that carefully designed policies not only reduce costs and stimulate investment but also generate significant environmental, social, and economic benefits, offering valuable lessons for Bangladesh's renewable energy policy.

3. Review of Existing Policy Guidelines and Exploring Incentive Scopes

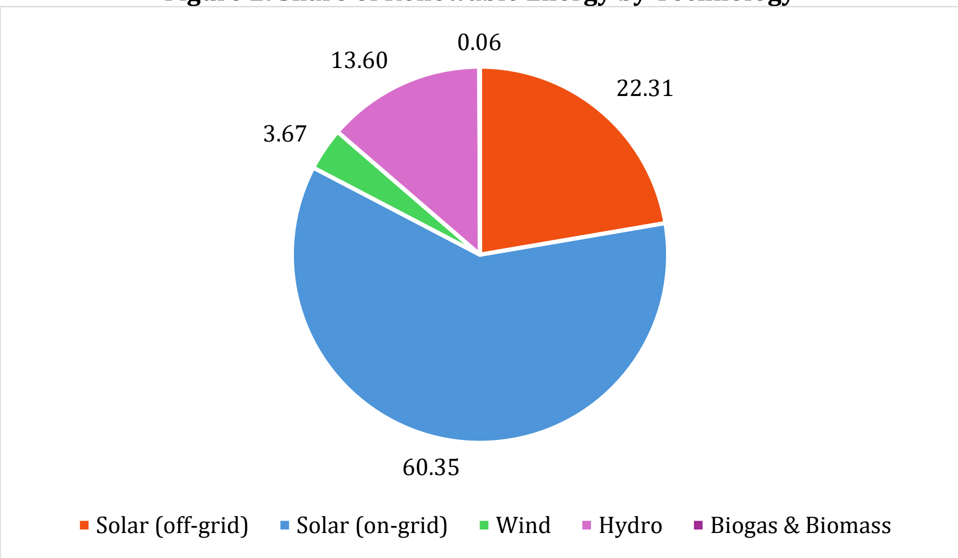
Bangladesh's power generation sector is heavily dependent on fossil fuels, with coal, gas, and other fuels accounting for more than 90% of power generation. Though fossil fuels dominate this sector, the energy landscape is slowly shifting towards renewable energy sources, reflecting a timely commitment to cleaner, more sustainable energy options. The latest data show that renewable energy contributes approximately 1,691 MW or 5.4% of the total installed capacity out of 31,389 MW (SREDA, 2025a). Figure 1 shows this mix of electricity generation in Bangladesh.

Figure 1: Electricity Generation Mix by Fuel Type in Bangladesh



Source: SREDA, 2025a

Figure 2: Share of Renewable Energy by Technology

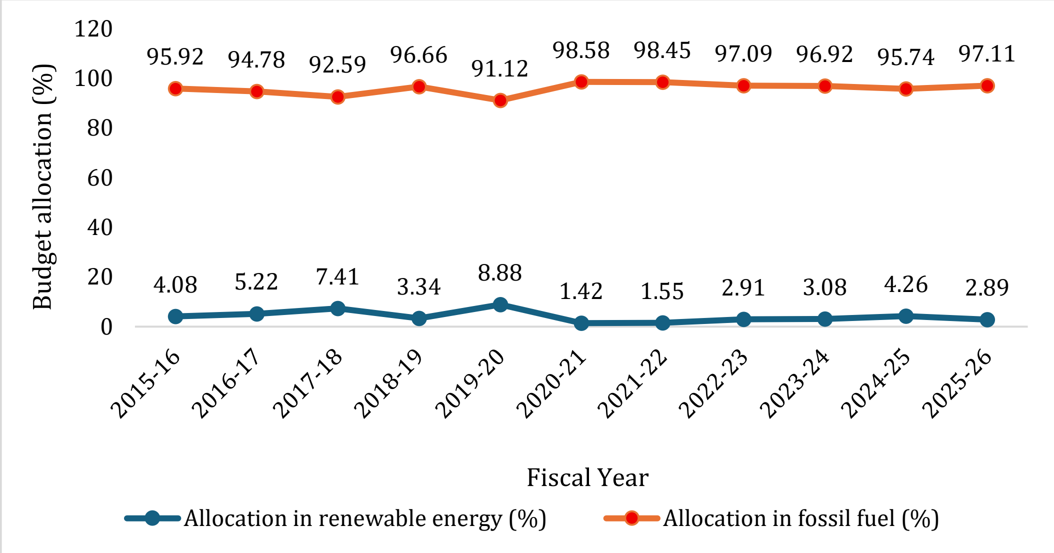


Source: SREDA, 2025b

Figure 2 shows that solar power dominates the renewable energy scenario, accounting for 82% of total renewable capacity, split between off-grid (22%) and on-grid (60%)

installations. Wind energy contributes 4%, hydropower 14%, and biogas and biomass together make up less than 0.1% (SREDA, 2025b).

Figure 3: Trends in Energy Budget Allocation Between Renewable and Fossil Fuels



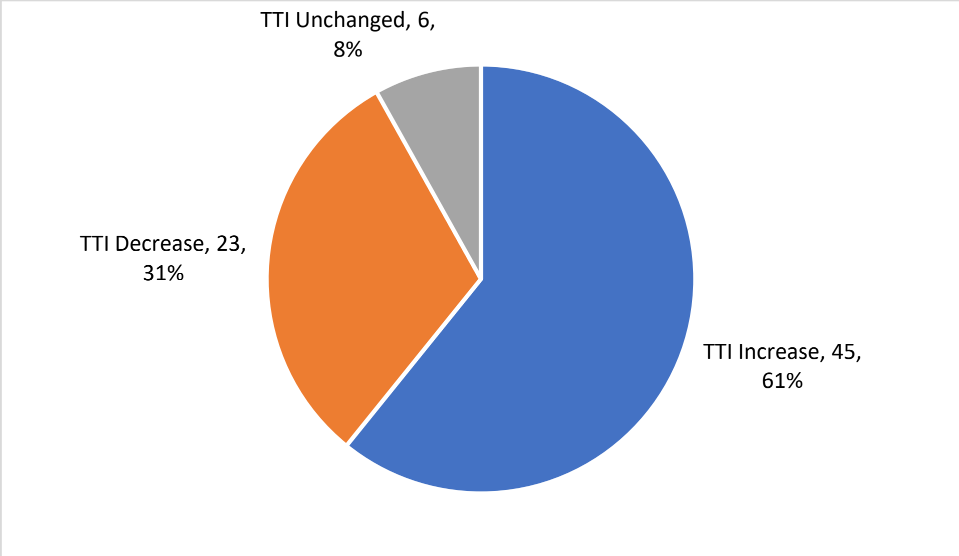
Source: Authors' calculation based on the Ministry of Finance (2025)

Despite a gradual shift toward renewable energy, the government's budget allocations have not been consistent with its stated target. In the proposed budget for FY2025–26, the government has allocated Tk 225.20 billion to the power and energy sector, which is 25.72% less than the original FY2024–25 allocation of Tk 303.17 billion and a marginal 0.81% less than the revised FY2024–25 budget of Tk 227.04 billion (Khatun et al., 2025). As illustrated in Figure 3, renewable energy continues to receive limited fiscal attention, with only 2.89% of the sector's Annual Development Program (ADP) allocated to it. Over the years, budget priorities have been low and uneven. Allocations went up from 1.55% in FY2021–22 to 3.08% in FY2023-24, but then declined slightly in FY2024–25 and FY2025–26. This pattern indicates a gap between the policy emphasis on renewable energy and the limited budgetary support provided. The current fiscal allocations are insufficient to fast-track the transition to renewable energy across the broader sector (Khatun et al., 2025).

Beyond budget allocations, changes in the tax structure also play an important role in shaping the renewable energy landscape. From FY2022–23 to FY2024–25 (NBR, 2022, 2023, 2024a), the total tax incidence (TTI) across all renewable energy components remained unchanged. The first major adjustments appeared in FY2025–26 when targeted increases and reductions were introduced (NBR, 2025).

Analyzing the TTI over the past few years reveals that the total tax incidence increased by 61% for the renewable energy equipment we listed in various literature sources, such as Cao et al. (2018) and Jha (2013), for FY2025–26, compared to previous years. While 31% of the goods declined, TTI remained unchanged for 8% of the goods (Figure 4). Meanwhile, in the previous three financial years, we see almost no change in the TTI for these goods. A detailed table showing the Total Tax Incidence (TTI) for these selected renewable energy goods is provided in Annex A (Table A1).

Figure 4: Changes in Total Tax Incidence on Renewable Energy Equipment in FY2025–26



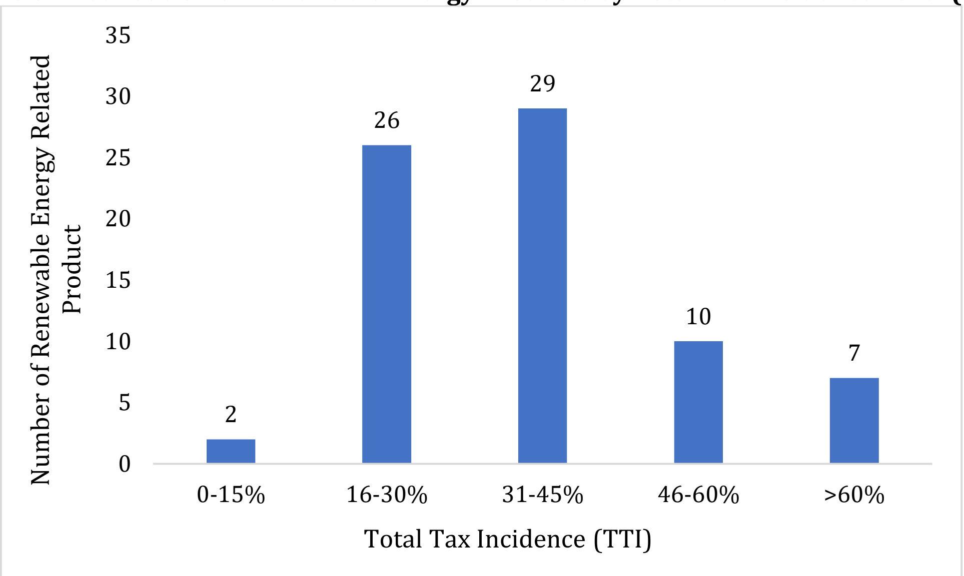
Source: NBR, 2025

Wind energy components had the highest share of commodities subject to a tax hike, accounting for almost 83% of the listed equipment, while 17% of the goods saw a tax reduction (Annex A, Table A1). Several primary technologies, such as wind-powered generating sets, pneumatic motors, electrical controllers, compressors, bearings, and gear systems, experienced a small increase in TTI. Their rates rose from 26.2% to 26.9% and in some cases from 37% to 37.25%. This could impose additional costs on developers and investors, as such components are crucial to turbine assembly and operation. At the same time, a smaller group of equipment benefited from slight reductions. TTI dropped by 0.2% to 0.45% for hydraulic turbines, wind-blade materials, air compressor parts, towers, and bearings. However, TTI remains high for some components, such as wind blade materials (73.74%) and air compressor parts (127.43%). Increases in TTI for core turbines and essential components could raise overall project costs, despite small reductions in TTI for certain supporting technologies.

Solar energy components experienced the widest range of revisions. The most notable changes are seen in photovoltaic technologies. TTI on unassembled solar cells increased slightly from 25% to 25.75%, while TTI on modules and panels rose from 26.2% to 26.9%. Similarly, a TTI of 0.25 to 0.7% higher is imposed on static converters and power regulation devices, photovoltaic generators, renewable-based generating sets, and thermostats. Conversely, some lighting devices and accessories recorded small reductions, such as photovoltaic LED lighting units, which fell from 127.72% to 127.43%. More practical adjustments were applied to upstream inputs. Polysilicon, an essential material for panel production, saw its TTI fall from 37% to 31.5%. TTI on lead-acid battery reduced by 0.24% and 0.2% for the two categories. Some auxiliary devices, such as solar cookstoves and selected equipment, saw reductions similar to those of batteries, but other items, including controllers and access systems, experienced upward revisions of 31% to 31.5%. Reducing taxes on polysilicon, batteries, and certain high-duty items helps lower costs in solar manufacturing and storage, but raising rates on widely used modules, converters, and control devices makes project implementation and consumer adoption more expensive.

Adjustments in the biomass sector have been relatively moderate. Raw materials such as wood pellets and general wood waste remained at a stable 10% TTI, which should keep feedstock affordable. Sawdust briquettes saw a small increase in TTI from 31% to 31.5%, which could slightly raise the cost of processed fuel inputs. TTI for gas burners, natural gas–based power generation units, wood-processing machinery, and biogas engines increased from 26.2% to 26.9%. TTI on biomass energy components, such as parts of producer gas and water gas generators, dropped from 26.2% to 25.75%, while larger biogas engines and alcohol-based fuels saw similar reductions. Rates for spark-ignition engines decreased from 53.6% to 53.4%, and both denatured and undenatured ethyl alcohol fell from 73.6% to 73.4%. Low TTIs on raw feedstock and small reductions on alcohol fuels and gas generator parts offer some support for biomass adoption. However, higher taxes on some components raise costs for investors and developers. Planned reductions in key components provide some support for renewable energy development. However, contradictory increases in supporting technologies and high-cost inputs indicate that fiscal and tax measures are not fully aligned with Bangladesh's renewable energy ambitions.

Figure 5: Distribution of Renewable Energy Products by Total Tax Incidence Level (TTI)



Source: NBR, 2025

Figure 5 shows the distribution of renewable energy products by their Total Tax Incidence (TTI) levels. Most products fall within the 31–45% TTI range, followed by 16-30%, indicating moderate taxation for the majority of equipment. Only a few products have very low (0–15%) or high (>60%) tax rates, showing that extreme tax levels apply to only a small number of components. This distribution highlights the variation in tax incidence across different renewable energy technologies.

To promote renewable energy expansion amid limited budget allocations and inconsistent tax incentives, the government has outlined a comprehensive policy framework to guide the sector's development. The Renewable Energy Policy 2025 has set ambitious targets: to meet 20% of national power demand from renewable sources by 2030 and 30% by 2040. These targets are consistent with the national priorities and international commitments, including the Paris Agreement. The policy emphasizes the key role of research and development, infrastructure development, institutional support, fiscal incentives, and effective grid integration in achieving these objectives. It introduces a range of fiscal and regulatory measures aimed at promoting investment, local manufacturing, and adoption of renewable energy technologies in Bangladesh, such as tax exemptions, customs and VAT relief, income tax benefits, and targeted support for developers and end-users (MoPEMR, 2025b). Table 1 summarises the key fiscal and regulatory measures introduced under the Renewable Energy Policy 2025 to support investment, local manufacturing, and the adoption of renewable energy technologies in Bangladesh.

Table 1: Key Fiscal and Regulatory Measures under the Renewable Energy Policy 2025

Policy Measure	Details
Import duty & VAT exemptions	Exemption from import duty and VAT on all renewable energy (RE) components, spare parts, and raw materials used in producing RE equipment, with periodic extensions based on impact assessments.
Corporate income tax exemptions	Full exemption for first 10 years for projects commissioned 1 July 2025 – 30 June 2030; partial exemptions over next 5 years (first 3 years at 50%, next 2 years at 25%). Applies to both public and private developers.
Equal incentives for foreign investors	Foreign investors via BIDA, BEZA, or BEPZA receive the same incentives as local developers.
Duty-free and VAT-free imports	For RE equipment, machinery, and raw materials not manufactured locally, subject to an accredited test report and an SREDA undertaking confirming the imports are solely for use in the specified plant and not for resale.
Direct pass-through of tax benefits	Mechanism to pass tax exemption benefits directly to end-users, which the Power Division will develop in consultation with NBR.
Customs duty incentives	Applied to specified RE components for project developers.
Wheeling charge waiver	For RE projects, establishing Electric Vehicle (EV) charging stations using the distribution utility network under open access.
Stamp duty exemption	Stamp duty exemption for registration of RE project lands, subject to approval from the Internal Resources Division (IRD).
Carbon trading incentives	Incentives for carbon trading, including income tax exemptions on revenue generated from such trading.

Source: MoPEMR, 2025

Table 2: Other Policies Related to Renewable Energy Equipment

Policy Name	Author & Date	Details
Customs Duty and VAT SRO-181	IRD, 2025	Reduction of VAT (5%) on locally produced E-bikes, with VAT, advance tax, and supplementary duty exemptions for raw materials under prescribed conditions
Income Tax SRO-400	NBR, 2024	Income tax exemptions on electricity sales by renewable energy projects to the grid or bulk users: full exemption for 10 years, followed by partial exemptions over the next 7 years (first 5 years at 50% and the next 2 years at 25%)
VAT SRO-1752	IRD, 2024	Permanent imports of generation plants and temporary imports of erection materials, spare parts, and accessories for both government and private projects are exempt from all applicable customs duties, VAT, and supplementary duty. However, customs duty shall not fall below 5%
Energy Efficiency and Conservation Master Plan up to 2030	MoPEMR, 2016	Under the Bangladesh Energy Efficiency and Conservation Master Plan up to 2030 (2016), investors are eligible for subsidies to install energy-efficient equipment, preferential taxation via reductions or exemptions, and concessional loans at discounted rates. These measures aim to facilitate the adoption of energy-efficient practices and technologies, with the long-term objective of improving energy efficiency and promoting sustainable energy consumption across Bangladesh

Source: Authors' Compilation from Various Policies

Table 2 highlights additional strategic policies introduced by the government to support emerging renewable energy technologies, facilitate electricity generation, and ease the import of equipment through targeted fiscal and regulatory measures.

Despite fiscal and regulatory incentives under the Renewable Energy Policy 2025, Bangladesh continues to face significant financing barriers for renewable energy projects. Average annual investment during 2018–2023 was only USD 238 million, well below the estimated USD 980 million required, while achieving 30% renewable energy by 2040 will require about USD 1.46 billion annually (Alam & Jena, 2025). Investor confidence has been weakened by policy and contractual uncertainties, including the suspension of non-competitive procurement and several LOI-backed projects. Low sovereign credit ratings, Taka depreciation, declining foreign direct investment, and BPDB's financial stress have further increased financing risks and borrowing costs. Additional challenges include costly land acquisition, long project payback periods, limited availability of long-term finance, insufficient concessional funding from IDCOL, an underdeveloped capital market, and restrictive collateral requirements for small-scale projects. These structural, financial, and policy constraints continue to hinder the capital mobilization needed for large-scale renewable energy deployment in Bangladesh.

To address these financing challenges, the Renewable Energy Policy 2025 (MoPEMR, 2025b) introduces a set of investment and financing mechanisms designed to facilitate both domestic and international funding, encourage private-sector participation, and create bankable, sustainable project opportunities (Table 3).

Table 3: Investment and Financing Measures under the Renewable Energy Policy 2025

Financing / Investment Measure	Description
Expansion of RE financing facilities	Access to public, private, development partner, and carbon market funds for bankable projects.
Micro-credit support	Extension of micro-credit in rural and remote areas to help developers purchase RE equipment.
Facilitation of investment	Encouragement of local and foreign investment in RE and energy-efficiency projects within legal frameworks.
Private sector participation	Support for private sector involvement and joint ventures in RE development.
SREDA incentive guidelines	Development of guidelines to provide incentives for solar, wind, biomass, and other RE projects.
Government support for sponsors	Provisions to facilitate financing for prospective sponsors implementing RE projects.
Renewable Energy Certificate (REC) mechanism	Promotion of RE projects under the REC framework.
RPO-linked project development	Allowing entities with Renewable Purchase Obligations (RPOs) to develop RE projects to meet their requirements.
Domestic manufacturing promotion	Promotion of domestic manufacturing of solar equipment, including cells, panels, inverters, mounting, and storage systems, with potential production-linked incentives.
Co-utilization of land	Incentives for co-utilization of land for solar energy, crop cultivation, and water preservation in agriculture, fisheries, and livestock sectors.
Energy efficiency promotion	Encouragement of renewable energy technologies to reduce grid electricity and gas consumption, particularly for water heating applications.

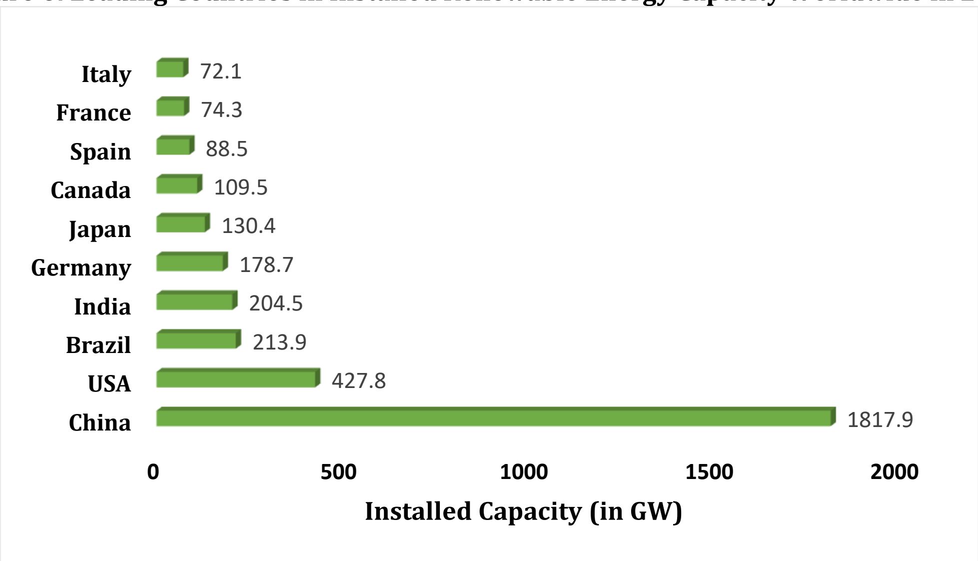
Source: MoPEMR, 2025

4. Experiences from Country Case Studies

In this study, India, China, and Germany have been chosen as the main focal nations for a successful renewable energy transition because of their diverse yet effective approaches to promoting clean energy under different institutional and economic circumstances. Due to its comprehensive state planning, industrial policy, and dominance of the supply chain, China leads the world, accounting for over 60% of renewable capacity additions in 2023. It makes more than 80% of global solar modules and 70% of its batteries (IEA, 2024b). The developing world's other big representative, India, is proof that market mechanisms and policy innovation can also speed deployment. In 2023, its installed renewable capacity surpassed 180 GW, driven by initiatives such as the Production-Linked Incentive Scheme and competitive reverse-bidding auctions that lowered solar costs below those of new coal generation (Michael, 2025). Germany's Energiewende, on the other hand, is a prime example of the institutional depth needed to maintain high renewable penetration. In 2023, renewables generated more than half of the country's electricity, thanks to flexible policies like the Renewable Energy Sources Act and massive citizen-owned energy projects (IEA, 2024a).

These nations collectively embody the market-driven (India), state-led (China), and institutionally anchored (Germany) transition paradigms, thereby offering an internationally applicable insight into building robust access to decarbonization with equity.

Figure 6: Leading Countries in Installed Renewable Energy Capacity Worldwide in 2024



Source: IRENA, 2025

4.1 The Case of India

India uses a mix of policies, ranging from tax incentives to feed-in tariffs (FIT), to promote renewable energy use. Tariff breaks are an important tool in this policy mix. These policies are summarised briefly in Table 4; they are discussed in detail later in this section.

Table 4: Overview of Key Fiscal Policies and Their Impact on Renewable Energy in India

Policy Instrument	Mechanism	Impact
Tax Incentives	Tax exemptions and rebates for renewable energy projects	Reduced financial burden on developers, increased investment in renewables
Renewable Purchase Obligation (RPO)	Mandates distribution companies to purchase a certain percentage of power from renewables	Created a market for renewable energy, ensured compliance with targets
Feed-in Tariffs (FITs)	Guaranteed prices for renewable energy sold to the grid	Provided a stable revenue stream for developers, encouraged solar and wind energy deployment
Renewable Energy Certificates (RECs)	Tradable certificates representing 1 MWh of renewable energy	Facilitated compliance with RPO targets, provided an additional revenue stream for generators
Generation-Based Incentive (GBI)	Financial incentive for wind energy generators	Increased wind energy capacity, promoted private sector investment
Solar Energy Promotion Scheme	Financial support for solar energy projects under NSM	Accelerated solar energy deployment, achieved NSM targets
Wind Energy Promotion Scheme	Financial incentives for wind energy projects	Increased wind energy capacity, promoted private sector investment

Source: Authors' Compilation from the Literature

4.1.1 Tax Incentives and Fiscal Policies in Successful Renewable Energy Transitions in India

India is fueling its renewable energy growth with ambitious laws and strategic financial incentives. Under the Glasgow Climate Pact, India has committed to increasing its renewable capacity to 500 GW and ensuring 50% of its power comes from renewable sources by 2030 (Singh et al., 2023).

The government has implemented several policies offering tax incentives, feed-in tariffs, renewable purchase obligations, and tradable renewable energy credits. Accelerating the development of renewable energy technologies reduces the amount of fossil fuels used in energy generation. Achieving energy security is another advantage. This section delves into the important fiscal policies and tax incentives that have aided India's successful renewable energy transition.

4.1.2 Role of Fiscal Policies in Promoting Renewable Energy

Fiscal policies have played a significant role in creating a favorable environment for the development of renewable energy in India. The government provides various financial incentives, such as tax rebates, subsidies, and low-interest loans, to encourage investments in renewable energy projects. India's fiscal incentives drive renewable energy growth: 80% accelerated depreciation in the first year, no excise duty on key products, low import tariffs on capital equipment, and five-year tax holidays for any renewable power project. These incentives have reduced the financial burden on developers, thereby making economic sense of renewable energy projects (Shrimali et al., 2017a; Singh, 2006; Singh & Sood, 2011).

One of the key fiscal measures introduced by the government is the provision of tax incentives for renewable energy projects. For instance, the Ministry of New and Renewable Energy (MNRE) has offered a 10-year tax exemption for renewable energy projects, significantly reducing financial risks. Such tax concessions reduce the tax liability of renewable energy projects by offering a 10-year income tax exemption during the first 15 years of operation. During the exemption period, projects must still pay Minimum Alternate Tax (20.81%), and after that, the standard corporate tax rate of 33.99% applies (Thapar et al., 2016). MNRE has been implementing capital subsidy schemes and soft loans through IREDA, nationalized banks, and a few other institutions to promote renewable energy. Several fiscal incentives are also available from the government, such as total or partial exemptions from excise duty, central sales tax, and customs duty on renewable energy equipment. Some of the relevant benefits available to renewable energy projects under the Income Tax Act included accelerated depreciation (80%), a full income tax deduction under Section 80-IA, a MAT exemption under Section 115J, and a 100% deduction for businesses processing biodegradable waste under Section 80JJA (Singh & Sood, 2011).

Also, the government has put in place plans and schemes for solar panels and other renewable energy technologies, which further reduce the cost of installing renewable energy. Aside from that, carbon taxes can lessen the use of fossil fuels and, at the same time, ignite clean energy. They may lead to high tariffs at first, but in the long run, once RE is developed continuously, costs will decrease (Bansal, 2021).

4.1.3 Tax Incentives and Their Impact

Tax incentives attract private-sector funding, fostering technological advancement and accelerating the deployment of renewable energy sources. Their effect can be seen in the booming renewable energy field, mainly in solar and wind power (Singh & Idrisi, 2020; Thakkar et al., 2024). However, as noted by Shrimali et al. (2017a), over time, policies based on debt, chiefly low-interest, long-term loans, are more efficient than existing subsidies. For wind energy, a 5.9% loan with a 10-year extension can cut total- i.e., the sum of federal, state, and tax subsidies by 78% compared to generation-based incentives. For solar, a 1.2% loan under similar terms reduces subsidies by 28% versus viability gap funding. This approach also enables substantial subsidy recovery-76% for wind and 49% for solar (Shrimali et al., 2017a).

For instance, the REC (Renewable Energy Certificate) scheme has enabled monetary incentives for Renewable energy generators, including the opportunity to trade their excess power onto the grid. This plan has also made it easier to meet the government-set RPO (Renewable Purchase Obligation) targets, while encouraging renewable energy project development (Sawhney, 2022; Singh, 2006; Singh & Sood, 2011).

4.1.4 Renewable Purchase Obligation (RPO) and Tradable Renewable Energy Credits

In India, another important piece of legislation supporting renewable energy is the Renewable Purchase Obligation (RPO). The 2003 Electricity Act created the Renewable Purchase Obligation (RPO). The Ministry of Power developed long-term growth plans in collaboration with MNRE, and the 2016 revision to the tariff policy required consistent RPOs across all states and union territories. 2018–2019 saw an increase in non-solar RPO targets from 8.75% to 10.25%, to reach 10.50% by 2021 (Singh & Idrisi, 2020). State-by-state variations in RPO targets are evident in Madhya Pradesh, which ranged from 0.5% to 10%. Under the RPO, distribution companies had to buy a certain percentage of their power from renewable sources. This has not only helped create a market for renewable energy but has also provided developers with adequate financial incentives to invest in renewable energy projects (Singh, 2006; Singh & Sood, 2011).

Renewable Energy Certificates (RECs) introduced by the government have made RPO implementation easier. The environmental characteristics of a single megawatt-hour of renewable energy are represented by RECs (Renewable Energy Certificates), tradable certificates. Trading these certificates on energy exchanges enables renewable energy producers to earn extra money (Narula, 2013; Sawhney, 2022).

4.1.5 Feed-in Tariffs and Their Role

Feed-in tariffs (FITs have played a significant role as a key fiscal policy tool in promoting renewable energy in India. Renewable energy generators can sell their power to the grid for a certain period through FITs at fixed prices. This policy promotes the development of solar and wind energy projects and provides developers with a stable revenue stream (Singh & Sood, 2011; Tryndina et al., 2022). The success of FITs in India lies in their ability to reduce the financial risks associated with renewable energy projects. FITs make projects more lucrative to investors and make the government's renewable energy targets more achievable (Singh & Sood, 2011; Thapar et al., 2016).

4.1.6 Fiscal Incentives for Solar and Wind Energy

The government has taken certain fiscal incentives for solar and wind energy projects to accelerate their deployment. For instance, the Solar Energy Corporation of India (SECI), under the National Solar Mission (NSM), provides financial incentives for solar energy projects. This includes capital subsidies, low-interest loans, and tax rebates. As part of Phase II of the National Solar Mission (MNRE, 2020), the viability gap funding (VGF) scheme has been approved for the development of 300 MW of grid-connected solar PV power by defense installations (Bansal, 2021).

Similarly, the government's Wind Energy Promotion Scheme provides financial incentives for wind energy projects. This includes a generation-based incentive (GBI) for wind energy generators, which has helped in increasing the share of wind energy in the overall energy mix (Chaurey et al., 2003; Shrimali et al., 2017b; Singh & Idrisi, 2020). Fiscal and financial support from MNES, along with funding from IREDA, has significantly accelerated the installation of grid-connected wind energy generators (GWEGs) in Tamil Nadu. IREDA has financed 210 such projects totaling 475 MW in the state, 22% of its nationwide wind project financing. Tamil Nadu's total installed wind capacity stands at 895 MW, accounting for 53% of India's overall wind energy capacity (Chaurey et al., 2003).

4.1.7 Challenges and Limitations

Although fiscal policies have been successful in promoting renewable energy, several challenges and limitations remain. Inconsistent implementation of fiscal policies across states has been a key challenge. This hinders the growth of the renewable energy sector in some regions as uncertainty rises for investors and developers (Singh & Sood, 2011).

Another challenge is the limited availability of financing options for renewable energy projects. The high upfront costs of renewable energy projects remain a barrier for many developers, despite the government's introduction of various fiscal incentives. This has necessitated innovative financing mechanisms, such as green bonds and crowdfunding, to bridge the financial gap (Chaurey et al., 2003; Thapar et al., 2016).

4.1.8 Conclusion and the Way Forward

India needs to keep promoting fiscal policies and tax incentives to meet its renewable energy goals. A stable and predictable policy environment, supported by government initiatives, can attract more private investment in clean energy. This includes making fiscal policies easier to implement across all states and offering new incentives for emerging technologies such as energy storage and smart grids (Janardhanan, 2012; Lobo et al., 2023). India also plans to expand biomass energy while gradually reducing its use of coal. The goal is to reach 550 GW of renewable energy by 2030. Along with this, improving energy efficiency to meet at least 10% of total energy demand by 2040 is crucial for a fair and sustainable shift to a low-carbon energy system (Lobo et al., 2023).

Additionally, the government should also find new ways to finance renewable projects. This can include using international green funds and encouraging public-private partnerships to attract additional investment (Chaurey et al., 2003; Thapar et al., 2016).

4.2 The Case of China

Fiscal policies and tax incentives have fueled the growth of China's renewable energy sector. The goal of these policies is to encourage investment in new technologies and energy efficiency improvements. The Chinese government's policies also include subsidies, tax rebates, and loans, which, comprehensively, improve the investment efficiency of enterprises in the renewable sector and mitigate financial and regulatory roadblocks to their growth. The following highlights these supportive measures and their key elements in more detail, though their more comprehensive treatment appears later in the section and is summarised in Table 5.

4.2.1 Tax Incentives

VAT Exemptions and Reductions: Tax incentives include policy interventions that provide more direct financial support. Among these, VAT exemptions have the most direct impact on the costs of renewable energy projects. For example, China offers a 50% VAT refund for solar projects. Such measures reduce operational costs and increase the profitability of green energy firms (Zhao et al., 2016).

Corporate Income Tax (CIT) Breaks: Renewable energy companies, particularly in wind and solar, benefit from significant CIT breaks. This often includes a "three-year full exemption followed by three-year 50% reduction" policy, which directly improves profitability and encourages long-term investment (Zhao et al., 2016). A study by Cao and Liu (2023) found that, without negatively affecting liquidity, long-term growth for green energy firms, especially those with higher tax burdens, is significantly enhanced by tax cuts. While Ying et al. (2024) found that long-term financial performance (measured by

Tobin's Q) of wind power companies is visibly enhanced by corporate income tax and VAT incentives, suggesting their use for innovation and expansion.

Table 5: Overview of Key Fiscal Policies and Their Impact on Renewable Energy in China

Policy Instrument	Mechanism	Impact
Tax Incentives	VAT Exemptions and Reductions: Up to 50% VAT refund on some solar projects to reduce costs (Zhao et al., 2016).	Lowers operational costs and improves the profitability of green energy firms.
	Corporate Income Tax (CIT) Breaks: "3-year exemption + 3-year 50% reduction" for wind/solar firms (Zhao et al., 2016). Confirmed to enhance growth without harming liquidity (Cao & Liu, 2023; Ying et al., 2024).	Encourages long-term investment, boosts financial performance, and innovation in renewable firms.
	Import Duty Refunds: Refunds on key renewable energy components like ≥2 MW wind turbines (Zhao et al., 2016).	Supports domestic manufacturing and R&D, lowers capital costs.
	Energy & Environment Taxes: Taxes to discourage fossil fuels and encourage clean energy (Wang & Shao, 2014).	Promotes a cleaner energy mix by raising the cost of fossil fuels.
	Tax Reductions for NEVs: Incentives improve NEV operational capacity and financing, with stronger effects in eastern China (Zeng et al., 2025).	Expands NEV adoption, sustains growth in the clean transport sector.
Fiscal Policies	Direct Subsidies: 600 Yuan/kW for wind, 5.5–7 Yuan/W for solar (Zhao et al., 2016).	Improves the financial viability of renewable projects.
	R&D & Demonstration Subsidies: Government funds support R&D and key renewable projects (Wang & Shao, 2014).	Stimulates innovation and technological progress.
	Project-Specific Incentives: Local subsidies (e.g., 3 yuan/W for PV roofs, 200 yuan/m^2 for solar hot water) (Wang & Shao, 2014).	Encourages local renewable adoption and diversification.
	"11th Five-Year Plan" Investments: 1.8 billion yuan state funding out of 14 billion total (Wang & Shao, 2014).	Accelerated renewable market expansion and innovation.
	Above-Market FITs: Guaranteed high rates (wind: 0.49–0.61 Yuan/kWh; solar: 0.9–1 Yuan/kWh) (Zhao et al., 2016).	Secured revenue streams, attracted large-scale investment.
	Transition to RPS/TGC: Shifting from FITs to Renewable Portfolio Standard with Tradable Green Certificates (Yan et al., 2024).	Encourages renewable electricity development but requires stronger TGC promotion.
	Soft Loans & Credit Supply: Credit from state banks, e.g., US$123 million solar rural electrification project (Bansal, 2021; Zhang et al., 2021)	Expands renewable generation capacity via lower financing barriers.
	Financial Investment & Competitive Bidding: Incentives for R&D and competitive procurement reduce solar prices (Chaurey et al., 2003; Wang & Shao, 2014).	Lowers technology costs, boosts efficiency.
	Government Procurement & Consumption Subsidies: Public procurement mandates + subsidies for renewable products (Wang & Shao, 2014).	Stimulates domestic demand and market expansion.

Source: Author's Compilation from the Literature

Import Duty Refunds: China offers import duty refunds for critical renewable energy components, such as large wind turbines (e.g., ≥2 MW), often tied to local research and development initiatives to support their domestic manufacturing and technological advancement (Zhao et al., 2016).

Energy and Environment Taxes: China aims to reduce associated costs by implementing energy and environmental taxes designed to curb fossil fuel use and promote clean energy alternatives (Wang & Shao, 2014).

Tax Reductions for New Energy Vehicles (NEVs): Tax incentives significantly boost the performance of NEV companies, particularly their operational capacity. These incentives also help ease financing constraints and have a long-term, sustained impact, especially in China's eastern regions (Zeng et al., 2025).

4.2.2 Fiscal Policies

Direct Subsidies: Direct government subsidies to renewable energy expenditures, including 600 Yuan/kW for wind power and 5.5–7 Yuan/W for solar power, alleviate the financial burden of these projects (Zhao et al., 2016).

R&D and Demonstration Subsidies: Significant R&D and demonstration subsidies are provided to research institutions and key renewable energy projects. There is also a dedicated fund for renewable energy production, where support is regulated (Wang & Shao, 2014).

Project-Specific Incentives: Provincial and city-level governments, such as Beijing, provide investment and production subsidies of at least 3 yuan/watt for photovoltaic roofs; 200 yuan/square meter for solar hot water; and 35 yuan/square meter for ground-source heat pumps (Wang & Shao, 2014).

"11th Five-Year Plan" Investments: Significant government investment, totaling 1.8 billion yuan (out of 14 billion yuan invested by society), accelerated market expansion and technological advancement in renewables during this period (Wang & Shao, 2014).

Above-Market FITs: Historically, China offered above-market feed-in tariffs (e.g., wind: 0.49–0.61 Yuan/kWh, solar: 0.9–1 Yuan/kWh) to guarantee revenue for renewable energy generators and encourage investment (Zhao et al., 2016).

Transition to RPS/TGC: Facing financial strain from FITs, China is transitioning to a Renewable Portfolio Standard with Tradable Green Certificates (RPS/TGC). This concurrent policy aims to encourage renewable electricity development, although its effectiveness depends on strong promotion of TGC subscriptions and addressing government subsidy reserves (Yan et al., 2024).

Soft Loans and Credit Supply: The government provides soft loans and various credit facilities (short-term, long-term, and total-term loans) to encourage substantial investments in tangible assets and expand renewable energy generation capacity (Zhang et al., 2021). The Bank of China, for instance, invested US$123 million in solar rural electrification (Bansal, 2021).

Financial Investment: China focuses on increasing financial investment to accelerate renewable energy technology R&D and offer investment incentives to boost production (Wang & Shao, 2014).

Competitive Bidding: A new mode of delivery relies on competitive bidding among potential suppliers of solar systems in western provinces, leading to lower prices for village power systems (Chaurey et al., 2003).

Government Procurement and Consumption Subsidies: Government procurement mandates actively promote renewable energy products. Consumption subsidies are also provided for renewable energy products to stimulate market demand (Wang & Shao, 2014).

4.2.3 Other Policies and Initiatives

Carbon Tax with Renewable Energy Investment (REI): Combining a dynamic carbon tax with REI more effectively reduces coal's share of power generation and mitigates negative economic impacts than a carbon tax alone (Wu et al., 2024).

Emission Targets and Smart Solutions: China aims to peak emissions by 2030 and achieve carbon neutrality by 2060. With renewed CO_2 and greenhouse gas emission targets, the widespread introduction of electric vehicles, energy-efficient technologies, and interactive air quality index monitoring systems, China aims to reduce carbon dioxide emission intensity by 60–65% while increasing solar energy capacity (Adelekan et al., 2024; Bansal, 2021).

Floating Solar Power Plants: China's implementation of large-scale floating solar power plants, such as a 40 MW facility, reduces land competition and increases efficiency through water-cooling effects (Bansal, 2021).

Fiscal Decentralization: Fiscal decentralization positively impacts renewable energy development, with subnational governments actively promoting it despite varied local conditions, leading to a "race to the top" (Zhang et al., 2022).

4.2.4 The Way Forward

While these policies have been largely effective, several challenges remain. Excessive reliance on subsidies can create inefficiencies and increase the government's financial burden. To achieve intended outcomes and prevent unintended consequences, policy implementation requires careful planning and continuous monitoring. A balanced strategy that combines tax incentives with other market-based instruments may provide a more sustainable pathway for China's renewable energy transition.

4.3 The Case of Germany

Germany has made impressive advances toward renewable energy through a mix of innovative policies, strategic fiscal incentives, and high targets (Table 6). Policies began with the Act on Supplying Electricity from Renewables (StrEG) in 1991 and were greatly accelerated by the Social Democratic-Green administration that came to power in 1998. What happened was essentially a breakthrough for wind energy, developed out of this act, which actually set compensation for electricity produced from renewables. It was replaced by the Renewable Energy Sources Act (EEG) in 2000, thereby strengthening and supporting market entry for biomass and solar photovoltaics (Bechberger & Reiche, 2004).

Investment subsidies, feed-in tariffs, tax exemptions, and less-direct policies are among the numerous policies the government has used to support renewable energy. To achieve energy security, reduce dependence on fossil fuels, and accelerate the uptake of renewable energy technologies, these measures have been crucial. In this section, the main tax incentives and fiscal policies that have supported Germany's transition to renewable energy are discussed.

Table 6: Key Fiscal Policies and Their Impact on Renewable Energy in Germany

Policy Instrument	Mechanism	Impact
Tax Incentives	Tax exemptions and rebates for renewable energy projects	Reduced financial burden on developers, increased investment in renewables
Feed-in Tariffs (FiTs)	Guaranteed prices for renewable energy sold to the grid	Provided a stable revenue stream for developers, encouraged solar and wind energy deployment
Investment Subsidies	Grants or soft loans for renewable energy projects	Direct financial support, reducing upfront costs, and encouraging market entry
Ecological Tax Reform (ETR)	Shifted tax burden from labor to energy consumption; biofuel exemptions, self-generated RES electricity exemptions; revenues reinvested in RES promotion	Encouraged sustainable energy use, boosted biofuel production, incentivized decentralized power, and funded further RES initiatives
100,000 Roofs Program	Long-term soft loans for PV installations	Accelerated PV deployment and market growth
Market Incentive Program (MAP)	Direct investment subsidies and soft loans for solar thermal, biomass, small hydro, and geothermal	Stimulated growth in renewable heat and other RES technologies
Energy Security of Supply Act	Permits restriction of sales, purchase, or use of goods; individual company responsibility for backup solutions	Ensures energy supply security during emergencies, promotes resilience
German Energy Act (EnWG)	Core objective to ensure the security of electricity and gas supply through power grids and pipelines	Maintains stable and reliable energy infrastructure, supports Energiewende challenges
EEG Levy (Surcharge on Electricity Bills)	Funds guaranteed, long-term feed-in tariffs for renewable producers; energy-intensive industries exempt from levy	Spurred massive investment in renewables, particularly from small-scale producers; financial burden shifted to households and small businesses

Source: Bansal (2021); Bechberger & Reiche (2004); Strunz et al. (2015)

4.3.1 Role of Fiscal Policies in Promoting Renewable Energy

The fiscal policies put in place have created a very favorable environment for the development of renewable energy. Some government financial incentives include investment subsidies (grants or soft loans) and tax exemptions under the Environmental Tax Reform. This went a long way toward reducing the developer's costs. In other words, it reduced their expenses, thereby making renewable energy more attractive and viable to use (Bechberger & Reiche, 2004).

Among the government's main fiscal measures is the offer of tax incentives for renewable energy projects. Major tax exemptions were introduced by the 1999 Ecological Tax Reform (ETR)—a full exemption led to a massive increase in biodiesel production. The targeted exemption enabled self-generated renewable electricity, thereby promoting decentralized power generation. Revenues from the ETR have been strategically invested to finance additional projects, such as MAP, which provides grants and subsidies for renewable heat technologies (Bechberger & Reiche, 2004).

Additionally, the government has introduced projects and schemes focused on solar panels and other renewable energy equipment. Among them is the 100,000 Roofs Program initiated in 1999 to provide long-term soft loans for PV installations. The Market Incentive Program (MAP), also launched in 1999, provided support for solar thermal systems, biomass combustion, small hydropower, and geothermal plants through direct investment subsidies and soft loans. The Environment and Energy Conservation Program (EECP) and the Environment Program (EP) by KfW also provided soft loans for RES projects, particularly wind energy (Bechberger & Reiche, 2004).

4.3.2 Tax Incentives and Their Impact

Tax incentives have been a cornerstone of Germany's renewable energy policy framework. These incentives have been designed to attract private sector investment, promote technological innovation, and accelerate the deployment of renewable energy technologies. The renewable energy sector, particularly solar and wind, has grown rapidly due to these incentives. The 1999 Ecological Tax Reform (ETR) introduced major tax exemptions, including a full exemption for biofuels and a targeted exemption for self-generated renewable electricity (Bechberger & Reiche, 2004).

However, the main fiscal framework driving Germany's renewable energy growth was the Renewable Energy Sources Act (EEG). Instead of general tax revenue, this plan paid for guaranteed long-term feed-in tariffs for renewable energy producers through a special extra charge, the EEG levy, added to electricity bills. The biggest push in this model was the generous exemption from the levy granted to energy-intensive industries to retain their global edge. This policy, however, shifted the financial burden of the energy shift mostly onto homes and small firms (Strunz et al., 2015).

4.3.3 Renewable Energy Sources Act (EEG) and Feed-in Tariffs

The Renewable Energy Sources Act (EEG) replaced the Act on Supplying Electricity from Renewables (StrEG) in 2000 and became the main policy instrument, achieving great success in promoting renewable energy. Under its provisions, it mandated guaranteed, long-term feed-in tariffs for renewable electricity, thereby significantly reducing financial risks for developers while providing a stable revenue stream. This has enabled significant investment in renewables, particularly from small-scale producers in Germany (Bechberger & Reiche, 2004; Strunz et al., 2015). Germany proved once more that the effective use of FiTs, especially in solar power, could serve as a model for other nations (Adelekan et al., 2024).

4.3.4 Investment Subsidies and Soft Loans

Germany provided investment subsidies in the form of grants or soft loans for renewable energy projects. For example, programs under long-term soft loans are offered under the umbrella of the 100,000 Roofs Photovoltaic Program (HTDP), initiated in 1999 for PV installations. The Market Incentive Program (MAP), also initiated in 1999, supports solar thermal systems, biomass combustion, small hydropower, and geothermal plants through direct investment subsidies and soft loans. KfW provides soft loans from the Environment and Energy Conservation Program (EECP) and the Environment Program (EP) to RES projects, among others (Bechberger & Reiche, 2004).

4.3.5 Ecological Tax Reform (ETR)

The Ecological Tax Reform (ETR) has been in effect since 1999, with a target shift in the total tax burden from labor to energy consumption; it has also introduced tax exemptions, including a full exemption for biofuels and a targeted exemption for self-generated renewable electricity, among others. Revenues realized under ETR were strategically invested in other key initiatives, such as the Market Incentive Program (MAP), which offers grants and subsidies for renewable heat technologies (Bechberger & Reiche, 2004).

4.3.6 Challenges and Limitations

Despite the success of fiscal policies in promoting renewable energy, several challenges and limitations remain to be addressed. While photovoltaics achieved record new installations, global overcapacity led to a sharp drop in prices, negatively impacting German manufacturers. The wind industry, however, remained successful (Lehr & Ulrich, 2017).

The government's support for renewable energy, through mechanisms such as feed-in tariffs, has led to higher electricity prices for households and firms, which is considered a negative budgetary effect. However, high PV production can sometimes offset price peaks (Lehr & Ulrich, 2017). The policy design, characterized by riskless remuneration schemes and high levels of technological differentiation, also led to a fragmented policy landscape and conflicts over decision-making power and rent distribution (Strunz et al., 2015). The strategic use of targeted levy and industry-specific exemptions under the EEG shifted the financial burden primarily onto households and small businesses (Strunz et al., 2015).

4.3.7 The Way Forward

Germany needs to continue promoting fiscal policies and tax incentives to achieve its ambitious renewable energy targets. The country aims for an 80% share of renewables in electricity consumption by 2050 (Adelekan et al., 2024). Germany's Energiewende also provides a compelling case study in job creation within the renewable sector, employing around 338,600 people in 2020 (Adelekan et al., 2024).

The German energy plans align with the overall European Energy Security Strategy and its targets, including increasing energy efficiency and achieving the 2030 energy and climate goals. Germany also aims to diversify suppliers and routes, given its high dependence on energy imports, particularly natural gas from Russia (Bansal, 2021). The German government is striving to improve its energy security by increasing energy efficiency, reducing the vulnerability of the energy system, and enhancing power grid stability, aiming at resource self-sufficiency at the national and regional levels (Bansal, 2021).

5. Economic Implications of Tax Reductions on Renewable Energy Components: A Cost–Benefit Analysis from a Partial Equilibrium Perspective

This chapter conducts a comprehensive cost–benefit analysis of reducing taxes on renewable energy goods to assess whether such fiscal reforms are economically justified in Bangladesh. It first establishes a conceptual framework grounded in public finance and welfare economics, which examines key cost components such as the marginal cost of public funds, fiscal revenue losses, and potential market distortions, alongside a wide range of economic, environmental, and social benefits. Building on this framework, the chapter then conducts an empirical exercise using import demand elasticities to evaluate how tax reductions affect prices, quantities, government revenue, and welfare. By integrating theoretical insights with elasticity-based empirical analysis, this chapter tries to determine whether increased demand, welfare gains, and long-term economic and environmental benefits can partially or substantially offset the short-term fiscal costs of tax reductions.

5.1 Cost Analysis

5.1.1 Marginal Cost of Public Funds (MCF)

The Marginal Cost of Public Funds (MCF) is a fundamental concept in public economics, representing the economic cost of raising additional revenue through taxation. The MCF measures the extent to which the overall economy is burdened by the distortionary effects of taxation, with higher MCF values indicating that raising funds through taxation imposes greater costs on society.

Dahlby (2008) outlines how the MCF varies with the type of tax implemented and the structure of the economy. When the government raises funds through taxes, it distorts consumer and producer behavior, leading to inefficiencies and welfare losses, commonly known as deadweight loss. In the context of renewable energy, policies that reduce taxes or offer tax incentives may lower the MCF by encouraging investment in low-carbon technologies and energy efficiency. As these investments can lead to significant long-term economic benefits, they could offset the initial fiscal costs of the tax reduction.

5.1.2 Fiscal Impact of Tax Reductions on Renewable Energy Goods

Reducing taxes on renewable energy goods can lead to immediate revenue losses for governments. However, the fiscal impact extends beyond these direct losses, encompassing potential long-term economic benefits and costs.

Revenue Loss: The immediate fiscal cost of tax reductions is the loss of revenue. When governments lower taxes on renewable energy goods, they forgo potential tax income. In the US, the Tax Cuts and Jobs Act of 2017 led to a 40% decline in overall tax revenue (Chodorow-Reich et al., 2024). Jha (2013) finds that reducing tariffs on renewable energy products may significantly reduce government revenues.

Market Distortions: Tax reductions can also lead to market distortions. While the intention is to stimulate demand for renewable energy goods, unintended consequences may arise. For example, Zhang et al. (2021) discussed how government subsidies and tax incentives can influence firm-level decisions in the renewable energy sector, potentially leading to inefficiencies if not carefully designed.

Impact on Government Spending and Budget Deficits: Tax reductions, especially those aimed at promoting renewable energy adoption, can significantly affect government spending and budget deficits. In the short term, tax cuts on renewable energy goods reduce government revenue. However, the long-term fiscal effects depend on the broader economic outcomes of these tax cuts, including the potential for increased economic activity, reduced environmental costs, and job creation in green industries.

Borenstein & Davis (2016) argue that the immediate budgetary effect of tax reductions on renewable energy goods often results in a budget deficit, as governments lose revenue. In some cases, this loss is offset by long-term gains from the stimulated adoption of cleaner technologies, which reduce future government spending on environmental mitigation and energy subsidies. For example, reducing taxes on renewable energy products can increase investment in clean energy infrastructure, thereby reducing reliance on fossil fuels and associated environmental cleanup costs. Over time, the government may save substantial amounts on healthcare costs related to air pollution and the economic costs associated with pollution-related illnesses.

Price Distortion and Long-term Economic Effects and Policy Adjustments: Jha (2013) finds that welfare gains from emission reductions are linked to cleaner energy sources, but that overall economic growth could be negatively affected by higher energy prices. For instance, tariff reductions could suddenly make investment in RE more lucrative. Distorting priorities and causing short-term energy price hikes that could reduce employment and productivity, with long-term economic implications.

5.2 Benefit Analysis

Lower Energy Costs and Enhanced Energy Security: Reducing taxes on renewable energy goods can significantly lower energy costs for households and businesses. A study found that tax rebates improve total factor energy productivity, indicating that tax incentives can lead to more efficient energy use and cost savings. This is particularly relevant for energy-intensive sectors like textiles and manufacturing in Bangladesh (Liu & Xia, 2023).

Further, adopting renewable energy can enhance energy security by reducing a country's reliance on imported fossil fuels. The International Renewable Energy Agency (IRENA) has emphasized the importance of renewable energy in reducing dependency on imported fuels and improving energy resilience. In Bangladesh, transitioning to domestically sourced renewable energy can improve energy resilience and reduce vulnerability to global energy price fluctuations.

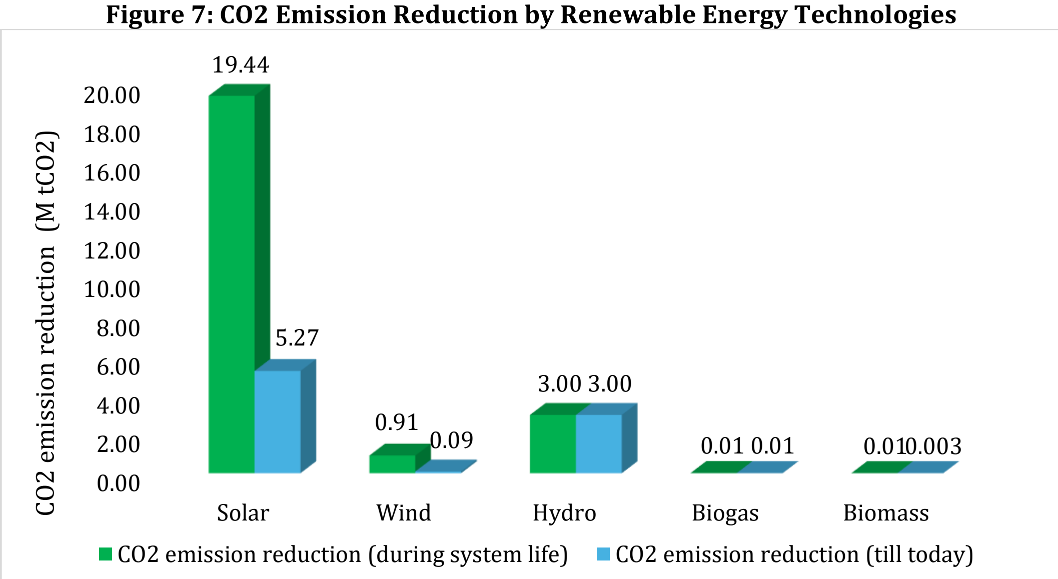
Increased Private Investment and Economic Growth: Tax reductions can stimulate private-sector investment in renewable energy (Raihan et al., 2025b). Research by Mazzucato (2018) and IRENA (2020) suggests that tax incentives for clean energy technologies often attract both domestic and foreign investment. This increased investment supports innovation, accelerates market growth, and leads to new business opportunities, particularly in sectors such as renewable energy manufacturing, installation, and maintenance.

The renewable energy sector's growth also has multiplier effects, as it creates jobs in related industries. A study by Hanna et al. (2024) found that renewable energy investments generate not only direct employment in energy production but also indirect and induced jobs across manufacturing, supply chains, research and development, and service sectors. These effects contribute to economic diversification and reduced reliance on traditional sectors like agriculture and textiles.

Reduction in Greenhouse Gas Emissions: One of the most significant benefits of reducing taxes on renewable energy products is the environmental impact. A study by Stern (2014) highlighted that the transition to renewable energy is one of the most effective ways to reduce greenhouse gas emissions, which contribute to climate change. Lowering the cost of renewable energy technologies accelerates the shift away from fossil-fuel-based energy generation, thereby reducing carbon emissions (Raihan et al., 2024c).

Figure 7 presents reductions in CO_2 emissions by different renewable energy sources in Bangladesh, based on SREDA data. The figure shows that solar energy accounts for the largest share of emission reduction, followed by hydro and wind, while biogas and biomass contribute relatively smaller reductions.

Figure 7: CO2 Emission Reduction by Renewable Energy Technologies



Source: SREDA, 2025

Job Creation and Skill Development: The expansion of the renewable energy sector will create numerous new job opportunities, particularly in manufacturing, installation, operation, and maintenance. According to IRENA (2020), the global renewable energy sector employed 12 million people in 2020, with significant job-creation potential in developing countries. The shift to renewable energy offers opportunities for skill development, especially for technicians, engineers, and project managers.

In Bangladesh, a country with high unemployment rates, especially among youth and women (Hasan et al., 2026), the renewable energy sector offers an opportunity to address unemployment and foster skill development. The creation of green jobs is a key part of Bangladesh's strategy to build a more sustainable economy (Sovacool & Dworkin, 2014).

Enhanced Access to Energy in Rural and Off-Grid Areas: One of the most significant social benefits of reducing taxes on renewable energy goods is improved energy access in rural and off-grid areas. By making solar technologies more affordable, tax reductions can increase access to reliable, clean energy for rural households, which currently rely on expensive, inefficient energy sources like kerosene. Improved access to energy will have cascading benefits for rural economies. Solar-powered irrigation systems, for example, can increase agricultural productivity, while solar-powered lighting in schools can enhance educational opportunities. Moreover, solar-powered medical devices in rural clinics can improve healthcare delivery, addressing some of the region's significant development challenges (Kabir et al., 2017).

Improved Public Health Outcomes: Renewable energy adoption can also have significant health benefits. Reducing air pollution from fossil fuel combustion will lower the incidence of respiratory diseases, particularly in urban areas. A study by WHO (2018) found that air pollution from fossil fuel combustion is a leading cause of respiratory diseases and cardiovascular conditions in cities worldwide. The transition to renewable energy, by reducing reliance on fossil fuels, can mitigate these health risks.

In rural areas, where biomass and kerosene are commonly used for cooking and lighting, the transition to renewable energy can also improve indoor air quality. This is particularly important in Bangladesh, where household air pollution is a significant health issue, especially among women and children who are more exposed to indoor smoke (Smith et al., 2004).

5.3 Results from the Empirical Exercise of Cost–Benefit Analysis

While the reduction in tax incidence on renewable energy goods will result in an immediate loss of government revenue, it is important to understand that the broader economic implications might not be as straightforward. In this section, we conduct an empirical analysis to evaluate how import demand elasticity affects the overall cost of tax reduction, ultimately benefiting consumers and suppliers.

5.3.1 Methodology

In economics, elasticity measures the responsiveness of demand to changes in price. Import demand elasticity measures the responsiveness of import demand to changes in costs and, in this study, helps assess how tax reductions affect demand for renewable energy products. Since a tax reduction is tantamount to a price reduction (Krugman et al., 2015; Mankiw, 2019), the formula for elasticity is as follows:

$$Elasticity = \frac{\%\ Change\ in\ Quantity\ Demanded}{\%\ Change\ in\ Price} \quad (1)$$

For our study, we selected 74 renewable energy-related equipment items with 8-digit HS codes, which aggregated to 41 6-digit HS products, as suggested by multiple literature sources (Cao et al., 2018; Jha, 2013). A table of this equipment list, along with their HS-codes, is provided in Annex A (Table A1). Using this list, we collected data from the UN COMTRADE website on these goods. We found the 2023 quantity imported and the corresponding value in USD. We estimate the unit price by dividing the total value of imports by the total quantity imported.

We then derive the elasticity figures. Grübler et al. (2022) use data from 167 countries spanning 1996-2014 on 5124 products to construct this product-level elasticity dataset. We then use our equipment list to select the intended products from this data and derive an 18-year average elasticity based on the available data, as shown in the second column of Table 7. Since very few products were imported by Bangladesh in 2023, from our initial list of 74, and even fewer have complete data on elasticity, price, and quantity, we use only 13 products listed in Table 7 for this analysis.

For these selected products, we have information on Total Tax Incidence (TTI), elasticity, quantity imported, and import value. We assume there is no domestic production of these goods, so the TTI is directly applied to the import value of the goods. The TTI is usually applied to goods at the 8-digit level. However, since we use trade data from COMTRADE, which provides import values only at the 6-digit level, we aggregate the TTI values for 8-digit products under each 6-digit product and then compute their average. This average value is then assigned to the 6-digit level classification. From Table 7, we can see that the TTI range is between 26.2% – 58.6% of the value of the goods. As per our goal, we want to reduce these TTI to 0-5%. So, we run 2 different analyses, one with 0% TTI and another with 5% TTI.

From the data, we can derive three price types: 0% TTI, 5% TTI, and the existing price with a government-imposed TTI. We can then compare price changes between the current TTI and the TTI at 0% or 5%. These price changes can then be used to derive quantity change using this formula-

$$Elasticity\ x\ \%\ Change\ in\ Price = \%\ Change\ in\ Quantity\ Demanded \qquad (2)$$

The percentage change in quantity demanded can be used to derive new quantities for each price level at 0% and 5% TTI. This is then used to derive new total revenue after the tax cut and account for variable elasticities, which we will call 'new revenue' for this analysis.

Here, the hypothesis is that volatility in elasticities will not allow the entire current tax revenue to be lost. Since tax reductions work like price decreases, they increase demand for each good; hence, some of the losses will be offset in the final revenue calculation, which accounts for the social welfare gain. These gains due to tax reductions are also known as welfare gains. These welfares accrue to society, either via consumer surplus or producer (read importer) surplus, whoever can capture the gain or has market power (Mankiw, 2019). This idea of revenue loss can be offset by elasticity, as observed by Chetty et al. (2009).

Elasticities: From Table 7, we observe that the elasticities for renewable energy goods are predominantly negative, indicating that demand for these goods is price-sensitive. This means that when the price of these goods decreases due to lower tax rates, demand increases.

For example, the Other Vapor Generating Boilers (HS Code: 840219) exhibit an elasticity of -0.9992803, which is very close to -1, indicating a unitary inverse relationship between price and demand. On the other hand, we can also see an elasticity of -.25 for wind power equipment parts, suggesting an almost inelastic relationship between demand and price.

Loss of Revenue: Loss of revenue is explained as follows:

$$Loss\ of\ Revenue = Revenue\ before\ tax\ cut - Revenue\ after\ tax\ cut(0\ elasticity) \quad (3)$$

Loss of revenue indicates the arithmetic loss of revenue if the TTI were reduced to 0% or 5% and no elasticity were present. For instance, a good bought for 100 USD with 26% TTI would cost 126 USD. A reduction to 0% TTI would result in a revenue loss of the full 26 USD. For this analysis, we present this loss of revenue as a percentage of new revenue.

Welfare Gain: The following equation explains welfare gain:

$$Welfare\ Gain = R_e - R_0 \quad (4)$$

Where,
$R_e = Revenue\ after\ accounting\ for\ elasticity\ at\ 0\%\ or\ 5\%\ TTI\ level$
$R_0 = Revenue\ with\ 0\ elasticity\ at\ 0\%\ or\ 5\%\ TTI\ level$

So, it is the difference between revenue after accounting for elasticity and before, at 0% or 5% TTI.

Net Loss: Net loss is presented as follows:

$$Net\ Loss = Loss\ of\ Revenue - Welfare\ Gain \quad (5)$$

Net loss is the actual revenue loss due to the tax cut, after accounting for elasticity variations. It is also expressed as a percentage of new revenue.

5.3.2 Findings

Revenue Loss and Welfare Gain

The analysis of TTI reductions reveals a clear trade-off between government revenue and consumer welfare. Figure 8 shows that reducing TTI to 0% results in substantial revenue losses across all products, ranging from 22% to 44%, with the largest loss observed for lead-acid cells for solar energy due to their high initial taxes. Figure 9 indicates that under a 5% TTI, revenue losses are lower, ranging from 16% to 38%, while welfare gains continue, particularly for highly price-elastic products.

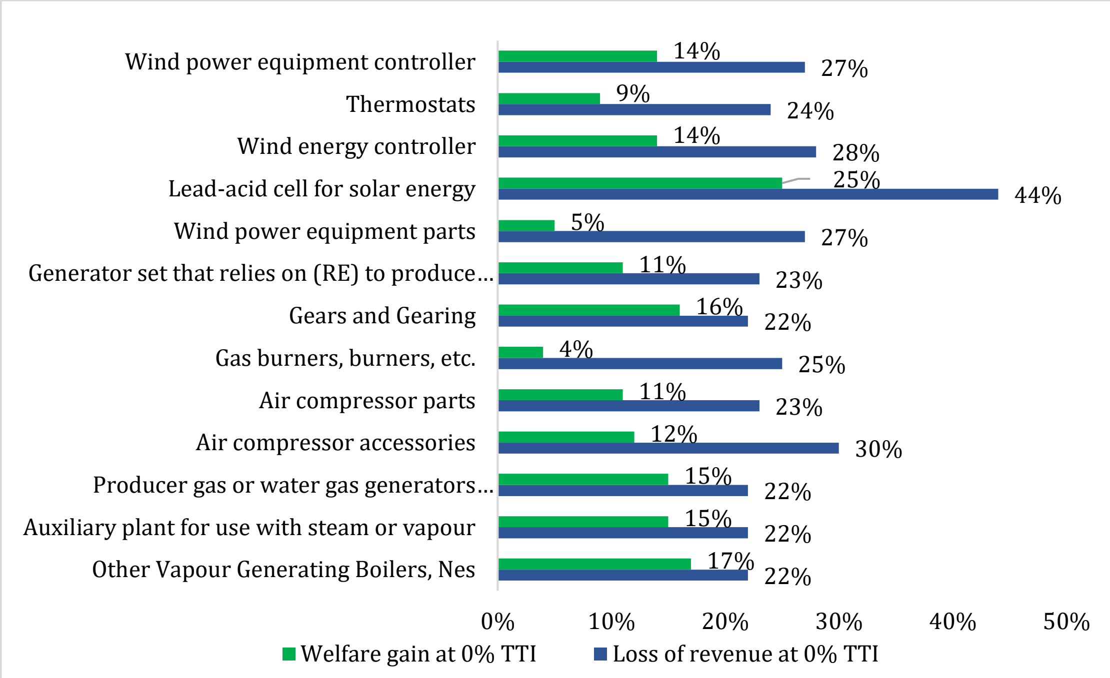
Table 7: Revenue Loss and Welfare Gain on Selected Items

Product name	HS Code	Elasticity	TTI	0% TTI Loss of Revenue	Net Loss	Welfare Gain	5% TTI Loss of Revenue	Net Loss	Welfare Gain
Other Vapor Generating Boilers, Nes (Incl. Hybrid Boilers)	840219	-0.999	26.2	22%	5%	17%	16%	3%	13%
Auxiliary plant for use with steam or vapor	840410	-0.841	26.2	22%	7%	15%	17%	5%	12%
Producer gas or water gas generators produce acetylene	840510	-0.821	26.2	22%	7%	15%	17%	6%	11%
Air compressor accessories (air duct)	841480	-0.552	34.2	30%	18%	12%	24%	14%	10%
Air compressor parts (impellers, blades, etc.)	841490	-0.588	26.2	23%	12%	11%	18%	10%	8%
Gas burners, burners, etc.	841620	-0.223	26.2	25%	21%	4%	19%	16%	3%
Gears and Gearing (Other than Tooth) (Wind Turbine Components)	848340	-0.900	26.2	22%	6%	16%	17%	5%	12%
A generator set that relies on renewable energy (RE) to produce electricity	850239	-0.616	26.2	23%	12%	11%	18%	9%	9%
Wind power equipment parts	850300	-0.250	29	27%	22%	5%	21%	17%	4%
Lead-acid cell for solar energy	850720	-0.909	58.6	44%	19%	25%	38%	16%	22%
Wind energy controller	853710	-0.664	33	28%	14%	14%	23%	12%	11%
Thermostats	903210	-0.495	26.2	24%	15%	9%	18%	11%	7%
Wind power equipment controller	903289	-0.695	31	27%	13%	14%	21%	10%	11%

Note: Loss of revenue, total revenue, and welfare gains are expressed as a percentage of the new revenue derived for 0% and 5% TTI after accounting for elasticity.

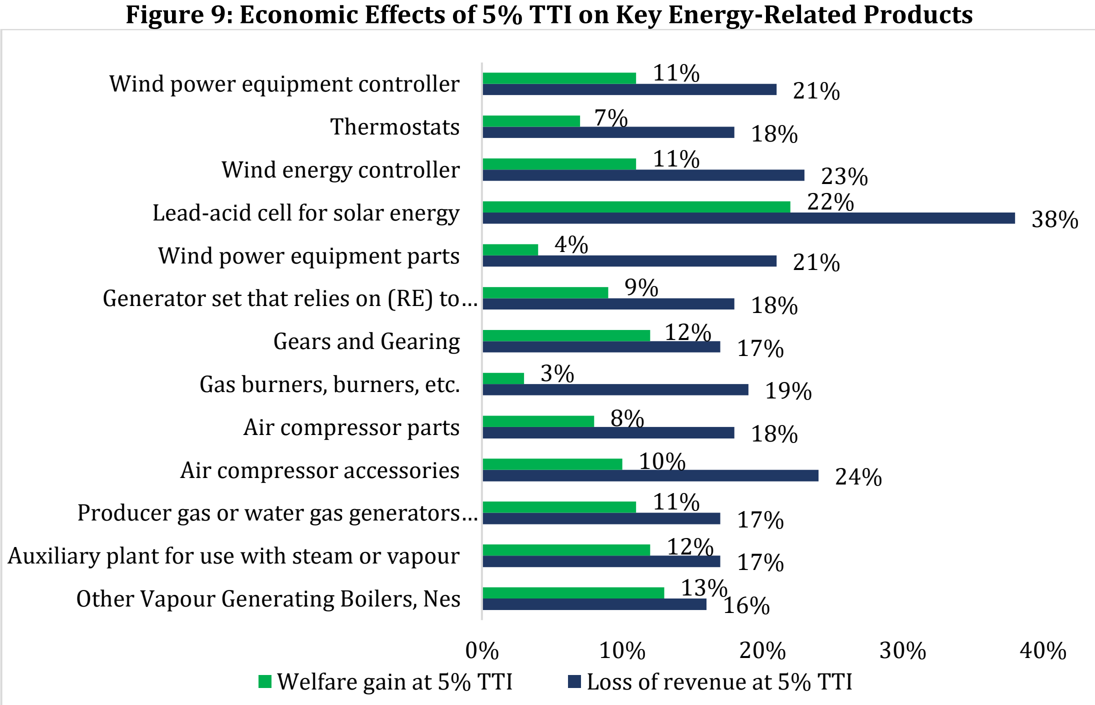
In terms of welfare gain, products with higher elasticity (such as Lead-acid cells for solar energy and Other Vapor Generating Boilers) also show higher welfare gains, with Lead-acid cells leading the pack with 25% and 22% gains at 0% and 5% TTI, respectively. At the same time, other vapor-generating boilers (Nes, incl. hybrid boilers) (HS code: 840219) have the second-highest welfare gain, despite a modest TTI of 26.2%. However, the elasticity for this 6-digit product is the most negative among the listed goods at -0.999. This suggests that a reduction in tax incidence for more elastic products can lead to significant consumer benefits, as lower prices stimulate demand.

Figure 8: Economic Effects of 0% TTI on Key Energy-Related Products



Source: Authors' Calculations Based on National Board of Revenue Data

Figure 9: Economic Effects of 5% TTI on Key Energy-Related Products

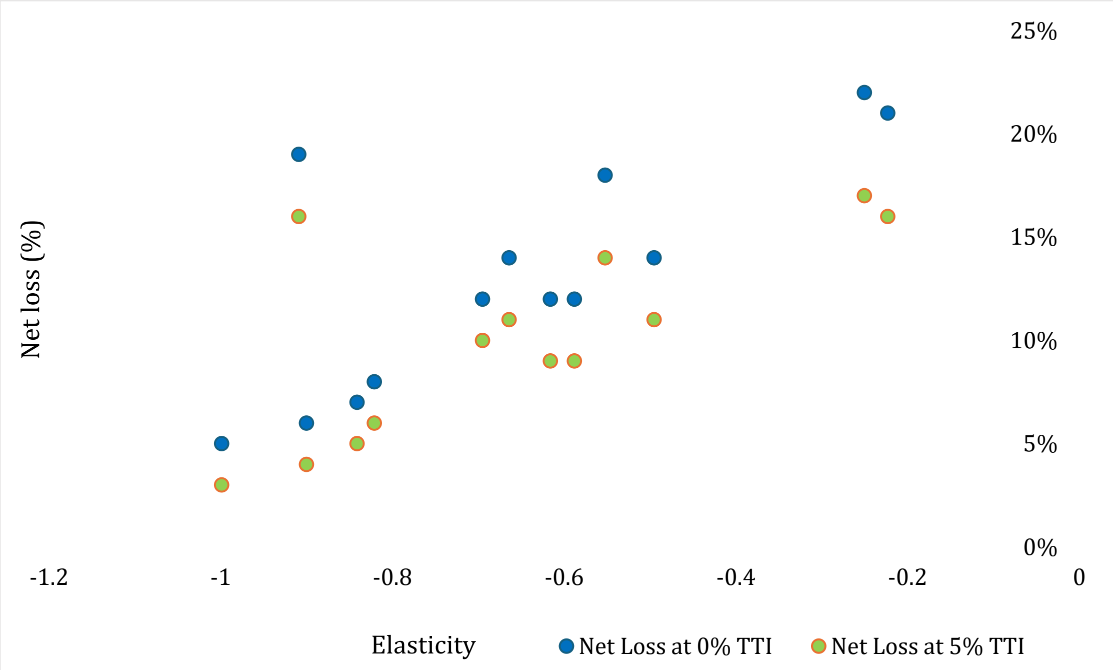


Source: Authors' Calculations Based on National Board of Revenue Data

Net Loss Analysis

Net loss, calculated as revenue loss minus welfare gain, varies across products (Figure 10). Highly elastic products, such as Other Vapor Generating Boilers (-0.999) and Lead-acid cells (-0.909), have smaller net losses (5–19%) because welfare gains offset a significant portion of revenue losses. In contrast, products with low elasticity, such as Gas burners (-0.223) and Wind power equipment parts (-0.250), experience higher net losses (16–22%) due to limited welfare gains.

Figure 10: Impact of TTI on Net Loss by Product Elasticity



Source: Authors' Calculations Based on National Board of Revenue Data

The partial equilibrium cost–benefit analysis conducted in this chapter offers an important but deliberately bounded assessment of the fiscal implications of reducing the Total Tax Incidence on renewable energy components in Bangladesh. The findings confirm that TTI elimination results in an immediate, arithmetic revenue loss for the government, ranging from 22% to 44% of new revenue, depending on the product. However, the analysis also demonstrates that this gross fiscal cost overstates the true economic burden, because demand elasticity moderates the net loss considerably. For high-elasticity products such as lead-acid solar cells and vapor-generating boilers, welfare gains of up to 25% partially absorb the revenue loss, reducing the net fiscal cost to as low as 5%. For low-elasticity products such as gas burners and wind power equipment parts, welfare gains are modest, and net losses remain higher, suggesting that product-specific, rather than blanket, tax-reduction strategies would be more fiscally prudent in the short run.

Taken together, these findings challenge the conventional fiscal concern that tax reductions on renewable energy goods are too costly to justify. The evidence shows that, for a significant share of renewable energy components, particularly those with higher price sensitivity, the net revenue loss is substantially smaller than the gross arithmetic reduction in tariff income would suggest. Moreover, it is essential to recognize what this analysis cannot capture. The partial equilibrium framework, by design, holds all other prices, incomes, and sectoral interactions constant, meaning it cannot account for the broader macroeconomic spillovers, sectoral productivity gains, household welfare improvements, employment multipliers, or the long-run fiscal savings from reduced fossil fuel subsidy expenditure that would follow from a comprehensive TTI elimination. These economy-wide effects, which are likely to be considerably larger than the direct welfare gains estimated here, can only be assessed through a general equilibrium framework. It is to this broader and more complete assessment that the following chapter turns.

6. Economic Implications of Tax Reductions on Renewable Energy Components: A Cost–Benefit Analysis from an Economy-Wide Perspective

The cost–benefit analysis conducted in Chapter 5, while instructive at the product level, operates within a partial equilibrium framework that isolates individual renewable energy equipment markets and holds all other prices, incomes, and sectoral interactions constant. This approach, by construction, cannot capture the full chain of economic consequences that unfolds when a fiscal reform of this nature is introduced. Tax reductions on renewable energy components do not affect only the markets for solar panels, inverters, or wind turbine parts in isolation; they ripple through input costs across all production sectors, influence factor market returns for labor and capital, alter government fiscal balances and public spending capacity, shift trade flows and the exchange rate, and ultimately affect real household incomes and consumption patterns across the entire economy. Ignoring these economy-wide feedbacks leads to an incomplete and likely conservative assessment of both the costs and benefits of the reform.

To address this, this chapter employs a Computable General Equilibrium (CGE) model calibrated with the 2022 Bangladesh Social Accounting Matrix, which simultaneously captures the behavior of 86 production sectors, 13 factor categories, 15 household groups, the government, and the rest of the world within a fully consistent accounting framework (Annex B for detailed methodology). A single policy scenario is simulated: a 100% reduction in the Total Tax Incidence (TTI) on all renewable energy–related components. In SAM, we identified five broad sectors listed in Table 8, including components we import not only for renewable purposes but also for other fossil fuel uses. Hence, we need to isolate the renewable energy share from the total import figures for each component. We find that, for these five components, the RE import share of total imports is 40%. Here, we assume that, on average, RE components have a 40% tariff. In the simulation, we assume a 40% reduction in tariffs for these five components, equivalent to a 100% tax reduction for selected RE components. The CGE results are then used to construct a comprehensive cost–benefit assessment to determine whether the economy-wide benefits of this reform outweigh its fiscal costs.

Table 8: Total Import Volume and Renewable Import Volume for the Selected RE Components in 2022

Components	Total Imports (in 1000 USD)	Renewables Imports (in 1000 USD)	Ratio
Electric transportation and storage	345,036.34	132,414.64	0.38
Electrical Equipment	940,353.66	558,763.31	0.59
Machinery and other equipment	1,644,847.37	622,821.62	0.38
Metal and metal products	819,504.07	186,206.85	0.23
Other chemicals	6,528.86	707.53	0.11
Grand Total	**3,756,280.85**	**1,500,913.95**	**0.40**

Source: Authors' Calculation Based on COMTRADE Data

6.1 The Cost Side: Fiscal Revenue Loss and Its Moderating Factors

The primary and most direct cost of eliminating the TTI on renewable energy components is the immediate loss of government tariff and tax revenue. The CGE results explicitly confirm this fiscal cost: import taxes as a share of GDP decline by 0.09 percentage points from the base value of 0.61%, reflecting the direct revenue foregone when customs duties, VAT, and supplementary levies on renewable energy components are reduced to zero (Table 9). Nominal government spending also contracts by 0.11% from its base of BDT 2.48 billion, indicating that the government's fiscal space narrows in the short term as tariff revenue falls. This is a real and quantifiable cost that must be taken seriously, particularly given Bangladesh's already constrained fiscal position and its relatively narrow tax-to-GDP ratio.

Table 9: The Cost Side: Fiscal Revenue Loss and Its Moderating Factors

Macro Indicators	Base Value	Change from the Base Value (%)
Government spending (Nominal)	2.48 (in Billion BDT)	-0.11
Import taxes / GDP	0.61	-0.09
Real exchange rate	100.00 (Index value)	0.12

Source: Static CGE Model Simulation

However, the CGE model simultaneously reveals three important mechanisms that moderate the true net fiscal cost of this reform and prevent the gross revenue loss from translating into an equivalent burden on the economy. First, the real exchange rate depreciates by 0.12% as the removal of import barriers on renewable energy equipment increases import demand, placing mild downward pressure on the domestic currency. While a weaker exchange rate carries its own risks, it simultaneously improves the price competitiveness of Bangladesh's exports, most critically textiles and garments, generating additional export earnings that partially offset the loss of import tax revenue through expanded economic activity and a broader income tax base.

Second, the reform stimulates a significant increase in import volumes of renewable energy equipment, driven by the sharp reduction in their landed cost. Higher import quantities partially compensate for the lower per-unit revenue, meaning the total import tax revenue loss is smaller than a simple arithmetic calculation of foregone per-unit duties would suggest.

Third, and most importantly, over the medium and long term, as renewable energy deployment accelerates in response to lower equipment costs, Bangladesh progressively reduces its structural dependence on imported fossil fuels, the very dependence that has cost the country an estimated US$3.22 billion annually in energy subsidies in recent years. The fiscal savings from a reduced subsidy burden on fossil fuel imports represent a substantial and growing offset to the tariff revenue foregone, one that compounds in value as the renewable energy transition deepens. Taken together, these moderating mechanisms mean that while the gross fiscal cost of the TTI elimination captured in the 0.09 percentage point decline in import taxes as a share of GDP and the 0.11% contraction in nominal government spending is non-trivial, the net long-run fiscal position of the government is considerably less adverse than these headline figures suggest.

6.2 The Benefit Side: Macroeconomic and Structural Gains

Against this fiscal cost, the CGE results present a compelling, multidimensional set of economic benefits. At the macroeconomic level, the complete elimination of TTI on renewable energy components results in a 0.04% increase in GDP from the base value of BDT 42.31 billion (Table 10). While this aggregate figure appears modest, it reflects a meaningful improvement in real productive capacity driven by lower energy input costs spreading across 86 production sectors simultaneously, an effect that no partial equilibrium analysis could capture. The Consumer Price Index falls by 0.02%, confirming that the cost reduction in renewable energy components passes through to economy-wide prices, moderating inflationary pressures and raising the real purchasing power of all economic agents. This is a particularly valuable benefit for Bangladesh, where inflation driven by energy and food costs has consistently eroded household welfare in recent years (Raihan et al., 2023).

Table 10: The Benefit Side: Macroeconomic and Structural Gains

Macro Indicators	Base Value	Change from the Base Value (%)
GDP at Market Prices	42.31 (in Billion BDT)	0.04
Exports	4.99 (in Billion BDT)	0.47
Imports	8.04 (in Billion BDT)	0.29
Consumer price index	100.00 (Index Value)	-0.02
Investment / GDP	32.01	0.01
Trade deficit / GDP	11.27	-0.04

Source: Static CGE Model Simulation

The trade impacts are unambiguously positive. Exports expand by 0.47% from the base value of BDT 4.99 billion as lower energy costs improve the cost competitiveness of Bangladesh's export-oriented industries, most critically the textiles and garments sector, which accounts for nearly two-thirds of total export earnings and is highly sensitive to energy input costs. Imports rise by 0.29% from the base value of BDT 8.04 billion, largely driven by increased demand for renewable energy equipment itself, as the removal of tariff barriers makes these goods significantly more affordable for domestic investors and consumers. Critically, the trade deficit as a share of GDP narrows by 0.04 percentage points from its base value of 11.27%, indicating that the export competitiveness gains outpace the rise in imports and generate a net improvement in Bangladesh's external balance. The Investment-to-GDP ratio improves by 0.01 percentage points from its base of 32.01%, reflecting stimulated capital formation in both renewable energy installation and the broader productive economy. These macroeconomic gains, higher output, lower prices, stronger exports, improved trade balance, and higher investment collectively constitute a robust set of benefits that extend well beyond the renewable energy sector itself and substantially outweigh the modest fiscal cost documented in the previous section.

6.3 The Benefit Side: Household Welfare Gains

Perhaps the most important benefits from a development and equity perspective are the household welfare gains from eliminating the TTI. The CGE model shows that real household income rises by 0.08% from the base value of BDT 31.47 billion, and real household consumption increases by 0.02% from the base value of BDT 28.11 billion, confirming that the economy-wide gains from the tariff reform translate directly into improved living standards for Bangladeshi households (Table 11). Two distinct, mutually reinforcing channels drive these gains. The factor income channel operates through expanded production and employment in sectors benefiting from lower energy costs, raising labor and capital returns across the economy. The price channel operates through the deflationary effect of reduced energy input costs on consumer prices, raising the real purchasing power of all households without requiring any direct expenditure transfer from the government.

Table 11: The Benefit Side: Household Welfare Gains

Welfare Indicators	Base Value (In Billion BDT)	Change from the Base Value (%)
Households' Real Income	31.47	0.08
Households' Real Consumption	28.11	0.02

Source: Static CGE Model Simulation

The distributional implications of these welfare gains are progressive and broadly equitable. Rural farm households benefit from lower energy costs for irrigation and mechanized agriculture, which raise agricultural productivity and farm incomes, directly supporting the livelihoods of the poorest quintiles, who depend most heavily on agricultural factor incomes. Rural nonfarm and urban poor households benefit disproportionately from consumer price deflation, as they devote higher budget shares to energy-related goods and services and therefore gain more in real terms from any reduction in the price level. Wealthier urban households also benefit through capital income gains as investment expands, but the proportional welfare improvement is more broadly distributed than in typical supply-side reforms. In a country where nearly 20% of the population remains below the poverty line (Raihan et al., 2025d; Raihan et al., 2021b; Raihan et al., 2020), and rural households consistently bear the greatest burden of energy cost shocks, the welfare gains from TTI elimination carry significant development value that extends far beyond what any standard revenue accounting can capture.

6.4 Benefits Outweigh Costs: An Economy-Wide Assessment

Taken together, the CGE results build a robust and coherent case that the economy-wide benefits of eliminating the TTI on renewable energy components substantially outweigh the reform's fiscal costs. On the cost side, the reform reduces import taxes as a share of GDP by 0.09 percentage points and contracts nominal government spending by 0.11%, representing the direct fiscal burden of forgoing tariff and tax revenue on renewable energy imports. These are real costs that must be acknowledged honestly. However, they need to be assessed not in isolation but against the full spectrum of economy-wide returns generated by the CGE model.

On the benefit side, the reform delivers GDP growth of 0.04%, export expansion of 0.47%, a 0.04 percentage point narrowing of the trade deficit, consumer price deflation of 0.02%, improved investment, and real household income and consumption gains of 0.08% and 0.02%, respectively. Each of these outcomes represents a tangible economic return on the fiscal investment required to eliminate the TTI. The export expansion alone, amounting to a 0.47% increase from a base of BDT 4.99 billion, generates additional economic activity, employment, and income tax revenue that partially compensates for the lost import tax receipts. The improvement in the trade deficit reduces pressure on

Bangladesh's foreign exchange reserves, a critical macroeconomic vulnerability that rising fossil fuel import bills have significantly strained in recent years. The consumer price deflation of 0.02% provides system-wide relief that benefits every household in the economy, with the largest proportional gains accruing to the poorest, who spend the highest shares of their income on energy-related goods.

Crucially, the CGE framework captures only the static, short-run general equilibrium effects of the reform. The long-run dynamic benefits that the model conservatively excludes are likely to be substantially larger. As lower tariffs accelerate the deployment of solar, wind, and biomass capacity across Bangladesh, the country will progressively reduce its structural dependence on imported fossil fuels. Given that Bangladesh's fossil fuel subsidy burden reached an estimated US$3.22 billion in recent years, even a modest acceleration in the renewable energy transition driven by this tariff reform would generate fiscal savings that dwarf the import tax revenue foregone. Every percentage-point reduction in fossil fuel import dependence translates into lower foreign-exchange outflows, reduced subsidy expenditure, and a structurally more resilient fiscal position, benefits that compound over time and are not captured in the static CGE results presented here.

The conclusion is unambiguous: the short-term fiscal cost of eliminating the Total Tax Incidence on renewable energy equipment is a necessary and economically justified investment. The CGE evidence demonstrates that this reform generates net positive returns across macroeconomic, trade, price stability, and household welfare dimensions in the near term, while laying the structural foundations for a more energy-secure, fiscally sustainable, and environmentally resilient Bangladeshi economy over the long run. The benefits, both measured and implied, substantially and convincingly outweigh the costs.

7. Conclusion and Policy Recommendations

7.1 Conclusion

Bangladesh stands at a structural crossroads. Its dependence on imported fossil fuels, which accounted for 62.5% of primary energy supply in FY2024–25 and generated a subsidy burden of nearly US$3.22 billion in recent years, poses a fundamental threat to the country's macroeconomic stability, fiscal sustainability, and long-term development ambitions. Achieving a US$1 trillion economy by 2034 demands a decisive shift away from this energy vulnerability, and the evidence presented in this report makes a compelling case that reforming the tax regime on renewable energy components is one of the most powerful and fiscally justifiable levers to accelerate that shift.

The study identifies 74 renewable energy-related products currently subject to a Total Tax Incidence ranging from 26% to 127%. Rather than declining in line with policy ambitions, in FY2025–26, 61% of these products experienced tax increases. In comparison, only 31% saw reductions, a pattern that directly contradicts Bangladesh's stated goals of achieving 20% renewable energy by 2030 and 30% by 2040 under the Renewable Energy Policy 2025. This fiscal contradiction, ambitious targets on one side and rising tax barriers on the other, constitutes the central policy problem this report addresses.

To build the evidential case for reform, the study synthesized lessons from successful renewable energy transitions in India, China, and Germany. Despite their very different institutional contexts, these three countries share a consistent lesson: the single most effective fiscal lever for accelerating renewable energy deployment is the dismantling of upfront cost barriers through strategically designed tariff reductions, tax exemptions, and investment incentives. India's market-driven reverse-bidding auctions, China's state-led industrial subsidies and VAT exemptions, and Germany's feed-in tariff architecture under the Renewable Energy Sources Act all confirm that fiscal policy and clean energy ambition must be aligned, not contradictory, for transitions to succeed.

The empirical analysis in Chapter 5, using import demand elasticities for 13 selected renewable energy products, tests this logic within Bangladesh's specific fiscal context. The findings confirm that reducing the TTI to 0% would result in gross revenue losses ranging from 22% to 44% of new revenue, a real and non-trivial fiscal cost. However, these losses substantially overstate the true economic burden. Demand elasticity moderates the net loss considerably: for high-elasticity products such as lead-acid solar cells (elasticity of -0.909) and vapor-generating boilers (elasticity of -0.999), welfare gains of up to 25% absorb a large share of the revenue loss, reducing net fiscal costs to as low as 5%. For lower-elasticity products such as gas burners and wind power equipment parts, net losses remain higher at 17–22%, suggesting that a differentiated, product-specific approach to tax reduction would be more fiscally prudent than a uniform blanket cut. Importantly, the partial equilibrium framework employed in Chapter 5 captures only the direct fiscal and consumer welfare effects; it cannot account for broader macroeconomic, sectoral, environmental, and social benefits that flow from accelerated renewable energy adoption, which are likely to be considerably larger.

These economy-wide effects are assessed in Chapter 6 through a Computable General Equilibrium (CGE) model calibrated with the 2022 Bangladesh Social Accounting Matrix. The simulation of a 100% TTI reduction on all renewable energy components reveals that the economy-wide benefits of the reform substantially and convincingly outweigh its fiscal costs. On the cost side, import taxes as a share of GDP decline by 0.09 percentage points, and nominal government spending contracts by 0.11%, resulting in modest real fiscal costs that are partially offset by higher import volumes, expanded economic activity, and reduced fossil fuel subsidy pressure. On the benefit side, GDP expands by 0.04%, exports increase by 0.47%, the trade deficit narrows by 0.04 percentage points, consumer prices decline by 0.02%, investment rises, and real household income and consumption improve by 0.08% and 0.02%, respectively. These gains are broadly distributed and progressive; rural farm households, rural nonfarm households, and low-income urban groups all benefit from lower energy input costs and reduced consumer prices. Moreover, the static CGE results conservatively understate the long-run benefits. As the renewable energy transition accelerates, Bangladesh will progressively reduce its structural dependence on fossil fuels, generating compounding fiscal savings from reduced subsidy expenditure that dwarf the tariff revenue foregone in the near term.

Taken together, the evidence across all three analytical pillars, international comparative evidence, partial equilibrium cost–benefit analysis, and economy-wide CGE simulation, converges on a single, unambiguous conclusion: the elimination or substantial reduction of the Total Tax Incidence on renewable energy equipment in Bangladesh is not merely an environmental policy choice. It is a fiscally sound, economically justified, and developmentally necessary investment that pays for itself through macroeconomic expansion, trade improvement, household welfare gains, and long-run energy security. Bangladesh cannot afford to maintain a tax regime that penalizes the very technologies it needs most to secure its economic future.

7.2 Policy Recommendations

The findings of this report support a comprehensive and layered set of policy recommendations spanning fiscal reform, institutional capacity, investment facilitation, and long-run structural transition. These are organized across three tiers reflecting the three analytical strands of the study.

7.2.1 Policy Recommendations Based on Existing Policies

Given existing financing gaps, disproportionate fiscal incentives, and structural barriers, Bangladesh should introduce targeted policy measures to strengthen and operationalize its existing renewable energy policy commitments. Table 12 provides recommendations outlining practical steps grounded in the current policy landscape. Such targeted measures will not only bridge existing gaps but also signal a stable and predictable policy environment, thereby strengthening business confidence (see Raihan et al., 2022b; Raihan et al., 2021a) and attracting greater private investment into Bangladesh's renewable energy sector.

Table 12: Policy Recommendations Based on Existing Policies

Category	Policy Recommendation
1. Tax and Fiscal Policy	**1. Unified TTI Reduction Strategy**: Lower TTIs on high-cost, essential components — solar panels, inverters, batteries, wind turbine parts — while strictly avoiding further tax increases on auxiliary equipment. A unified TTI reduction strategy across all renewable energy technology categories (solar, wind, biomass) is essential to improve affordability, attract investment, and eliminate the internal fiscal contradictions in the current tax structure.
	2. Support for Solar Irrigation Pumps (SIPs): Develop a unified tax strategy to reduce TTI on SIPs to 1–5% to improve affordability for smallholder farmers. Encourage grid-integrated SIPs with targeted subsidies for farms below a specified landholding threshold, enabling energy export during off-peak periods.
	3. Revised EV Duty Structure: Revise the duty structure for electric vehicles to reduce import duties and supplementary taxes, align annual taxes with vehicle capacity, and create a clear and stable fiscal signal for clean transport adoption.
2. Project Acceleration and Infrastructure Development	**4. Fast-Track Renewable Energy Projects**: Accelerate stalled and pipeline renewable energy projects under SREDA with dedicated project facilitation units, streamlined land acquisition procedures, and technical and financial support from international development partners, including the EU, ADB, and the World Bank.
	5. Net Metered Solar Projects: Prioritize net metered rooftop solar projects beginning with public buildings, schools, hospitals, and industrial facilities as a low-land, low-cost pathway to rapidly expanding renewable capacity.
	6. Green Building and RE Refinancing Scheme: Expand Bangladesh Bank's green refinancing scheme to cover a broader range of renewable energy and energy-efficiency investments, with enhanced collaboration with development finance institutions to scale up available funding.
3. Financial and Investment Support	**7. Develop a Robust Green Bond Market**: Prioritize the development of a sovereign and corporate green bond market to channel long-term institutional capital into renewable energy infrastructure. Strengthen the regulatory framework for green bond issuance and disclosure.
	8. Policy Coordination and Consistency: Establish a formal inter-ministerial coordination mechanism — involving NBR, MoPEMR, Ministry of Finance, Bangladesh Bank, and SREDA — to ensure consistent and predictable fiscal and regulatory signals to investors. Policy reversals and inconsistent TTI adjustments must be addressed structurally.
	9. Investment Risk Reduction: Implement a payment security mechanism or partial risk guarantee facility for utility-scale renewable projects to address counterparty risk arising from BPDB's financial stress. Establish currency hedging instruments for foreign-funded renewable energy projects, given the 27% depreciation of the Taka between May 2022 and January 2025.

7.2.2 Policy Recommendations from the Empirical Exercise

The elasticity-based cost–benefit analysis yields a clear set of product-differentiated policy recommendations to guide the NBR's approach to TTI reform.

Prioritize Tax Reductions for High-Elasticity Products

Policymakers should begin TTI reductions with high-elasticity products, such as lead-acid solar cells, vapor-generating boilers, gears and gearing for wind turbines, and auxiliary steam plant equipment, where demand is highly responsive to price reductions. For these products, welfare gains of 15–25% substantially offset the revenue loss, reducing the net fiscal cost of TTI elimination to as low as 5–8%. Accelerating the adoption of these components delivers the highest renewable energy uptake per unit of fiscal cost. The NBR should establish a priority list of high-elasticity renewable energy products and implement phased TTI reductions beginning with this group in the immediate budget cycle.

Targeted Reductions for Products with Moderate Elasticity

For products with moderate elasticity, renewable energy generator sets, wind energy controllers, wind power equipment controllers, and air compressor accessories, a reduction to 5% TTI rather than full elimination represents a pragmatic and fiscally responsible first step. This approach stimulates meaningful demand increases and generates welfare gains of 9–14% while preserving a modest revenue base during the fiscal transition. A clear roadmap toward full TTI elimination for these products within a defined three-to-five-year horizon would provide the investment predictability that developers and importers need.

Cautious and Complementary Approaches for Low-Elasticity Products

For products with low elasticity, such as gas burners and wind power equipment parts, TTI reductions alone yield limited welfare gains of 3–5% and leave net fiscal losses relatively high at 17–22%. For these products, policymakers should complement any tax reductions with direct subsidies, rebates, subsidized financing schemes, or production incentives, rather than relying solely on tariff cuts. This avoids significant revenue loss without stimulating demand, while still supporting broader renewable energy deployment.

Combine Tax Reductions with Complementary Fiscal Instruments

Tax reductions alone are necessary but not sufficient. The NBR and MoPEMR should develop a complementary toolkit including investment tax credits for renewable energy project developers, production-linked incentives for domestic manufacturing of solar and wind components, R&D grants for emerging clean energy technologies, and direct consumer rebates for household-level renewable energy installations. These instruments address the supply-side investment gap while ensuring that demand-side cost reductions reach end users effectively.

Institutionalize a Periodic TTI Review Mechanism

Given the rapidly evolving nature of renewable energy markets, technology costs, and global trade patterns, the government should institutionalize a periodic review of TTI rates on all renewable energy components, ideally on a two-year cycle, anchored in transparent elasticity and welfare data. This review should be housed within a joint NBR-SREDA technical working group, with the findings published to inform each national budget cycle. Such a mechanism would replace the ad hoc, often contradictory annual TTI adjustments that have characterized Bangladesh's recent fiscal approach and would build the policy consistency that investors and developers require.

Ensure Direct Pass-Through of Tax Benefits to End Users

The fiscal benefits of TTI reductions must be transmitted to end users, households, small businesses, and rural consumers, rather than being captured at the importer or distributor level. The Power Division's mandate under the Renewable Energy Policy 2025 to develop a direct pass-through mechanism in consultation with the NBR should be operationalized with urgency, including clear pricing regulations and market monitoring to ensure that border price reductions translate into lower costs for final consumers.

7.2.3 Policy Recommendations from the Economy-wide Analysis

The CGE model results provide a macroeconomic and structural policy framework that goes significantly beyond the product-level recommendations of the partial equilibrium analysis. These recommendations address the systemic, economy-wide conditions necessary for Bangladesh to realize the full benefits of the TTI reform and transition to a structurally more resilient energy economy.

Implement Full TTI Elimination as a Macroeconomic Growth Policy

The CGE results confirm that a 100% reduction in TTI for renewable energy components is not merely an energy-sector reform but a macroeconomic growth policy. The GDP expansion of 0.04%, export increase of 0.47%, trade deficit improvement of 0.04 percentage points, and consumer price deflation of 0.02% collectively constitute a macroeconomic stimulus (Raihan et al., 2024d) that the government should communicate and pursue as part of its broader economic stabilization and competitiveness agenda, not only as an environmental commitment. The Ministry of Finance and Bangladesh Bank should incorporate the macroeconomic co-benefits of TTI reform into their medium-term fiscal and monetary planning frameworks.

Offset Short-Term Revenue Loss Through Fossil Fuel Subsidy Rationalization

The CGE results show that the immediate fiscal cost of TTI elimination, a 0.09 percentage point decline in import taxes as a share of GDP and a 0.11% contraction in nominal government spending, is real but manageable. The government should finance this transitional cost through a phased rationalization of fossil fuel subsidies, which have burdened public finances by US$3.22 billion annually. Redirecting even a modest share of this subsidy expenditure toward supporting the renewable energy transition would more than compensate for the tariff revenue foregone and yield a fiscal double dividend: lower subsidy costs and higher tax revenues from an expanded, more productive economy.

Leverage Exchange Rate Dynamics for Export Competitiveness

The CGE model shows that the TTI reform induces a 0.12% real exchange rate depreciation, which, combined with lower energy input costs across production sectors, improves export competitiveness, particularly for the textiles and garments sector, which accounts for nearly two-thirds of Bangladesh's total export earnings. Bangladesh Bank and the Ministry of Finance should coordinate exchange rate and monetary policy to ensure that this competitiveness effect is sustained and not offset by other macroeconomic interventions. The export expansion of 0.47% from a base of BDT 4.99 billion represents a meaningful and immediate boost to foreign-exchange earnings, strengthening the overall balance of payments.

Protect and Deepen Household Welfare Gains Through Complementary Social Policy

The CGE model confirms that the welfare benefits of TTI elimination are broadly progressive. Rural farm households benefit from lower agricultural energy input costs; rural nonfarm and urban poor households benefit from consumer price deflation; and lower-income groups gain proportionally more from real purchasing power improvements than wealthier households. To ensure these gains are fully realized, the government should complement the TTI reform with targeted welfare measures, including subsidized solar home systems for off-grid rural households, solar-powered irrigation support for smallholder farmers, and energy literacy programs that enable rural communities to benefit from expanding renewable energy access. These measures will deepen the distributional benefits of the reform and directly advance Bangladesh's poverty reduction objectives.

Establish a National Energy Transition Fund

The long-run structural transformation implied by the TTI reform, a progressive shift from fossil fuel import dependence toward domestically deployed renewable energy, requires sustained and dedicated public investment beyond what annual budget cycles can reliably provide (Raihan et al., 2024a). The government should establish a National Energy Transition Fund, capitalized through a combination of rationalized fossil-fuel subsidy savings, sovereign green bond proceeds, and climate finance from international sources, including the Green Climate Fund (GCF) and the Asian Development Bank's climate financing windows. This fund should finance grid infrastructure modernization, battery storage capacity, domestic renewable energy manufacturing, and support for a just transition for communities currently dependent on fossil fuel industries.

Align the Annual Budget Cycle with Renewable Energy Targets

The most fundamental structural recommendation emerging from this study is the need to align Bangladesh's annual fiscal planning cycle with its long-term renewable energy targets. The FY2025–26 budget allocated only 2.89% of the energy sector's Annual Development Program to renewable energy, far short of what is required to meet the 2030 and 2040 targets. The government should establish a statutory minimum renewable energy budget share, beginning at 10% of the energy sector ADP and rising progressively in line with deployment milestones, and link TTI adjustments directly to annual renewable energy progress reviews. Fiscal policy and energy policy must speak with one voice if Bangladesh is to close the implementation gap between its stated ambitions and the on-the-ground reality of its energy transition. The evidence presented in this report provides the analytical foundation to do exactly that.

Annex A: Total Tax Incidence (TTI) on Renewable Energy-Related Components

Table A1: The categories of renewable energy products (REPs) and their Harmonized Commodity Description and Coding System (HS) codes

Product Category	Commodity Code (6 digit HS Code)	Commodity Descriptions	Commodity Code (8 digit HS Code)	Commodity Descriptions	Total Tax Incidence (TTI) 2022-23	Total Tax Incidence (TTI) 2023-24	Total Tax Incidence (TTI) 2024-25	Total Tax Incidence (TTI) 2025-26
Wind Energy products	**841239**	Other pneumatic power units	**84123900**	Pneumatic Power Engines and Motors (Excl. Linear Acting)	26.2	26.2	26.2	26.9
	850231	Wind power equipment	**85023100**	Wind-Powered Generating Sets	26.2	26.2	26.2	26.9
	850300	Wind power equipment parts	**85030010**	Parts of Photovoltaic Generators of Heading No 85.01 Or 85.02	26.2	26.2	26.2	26.9
			85030020	Parts of the Other Generator	26.2	26.2	26.2	26.9
			85030030	Rotor/Motor bush/Casing for electric motors	26.2	26.2	26.2	26.9
			85030091	Stator with winding wire		43	43	43
			85030092	Stator Without Winding Wire		26.2	26.2	43
			85030099	Stator other than with/without winding wire		26.2	26.2	26.9
	903289	Wind power equipment controller	**90328900**	Automatic Regulating or Controlling Instruments and Apparatus, Nes	31	31	31	31.5
	722840	Forging tool round steel (mainly used for wind energy)	**72284000**	Bars and Rods Of Alloy Steel Not Further Worked Than Fooged	37	37	37	37.25
	853710	Wind energy controller	**85371010**	BUSBAR TRUNKING SYSTEM	26.2	26.2	26.2	26.9
			85371020	Electric panel	26.2	37	37	37.25
			85371090	Other	37	37	37	37.25
	841480	Air compressor accessories (air duct)	**84148010**	Air Compressors	26.2	26.2	26.2	26.9
			84148020	Pumps & Compressors; Hodds With A Fan, Blowers for Use In Piciculture Only	26.2	26.2	26.2	26.9

Product Category	Commodity Code (6 digit HS Code)	Commodity Descriptions	Commodity Code (8 digit HS Code)	Commodity Descriptions	Total Tax Incidence (TTI) 2022-23	Total Tax Incidence (TTI) 2023-24	Total Tax Incidence (TTI) 2024-25	Total Tax Incidence (TTI) 2025-26
			84148030	Pumps and compressors	31	31	31	31.5
			84148041	Industrial Type	26.2	26.2	26.2	26.9
			84148049	Compressor Excl Industial and VAT MFG AIRCON	37	37	37	37.25
			84148090	Other Air Pumps; Air or Gas Compressors; Hoods with A Fan, Nes	58.6	58.6	58.6	58.4
	841490	Air compressor parts (impellers, blades, etc.)	**84149010**	Parts of Fan	127.72	127.72	127.72	127.43
			84149020	Of compressor imported by VAT registered compressor manufacturers	37	37	37	37.25
			84149090	Parts of Air/Vacum Pumps, Of Air/Gas Compressors, Nes	37	37	37	37.25
	392099	Plastic sound board on the wind blade	**39209910**	Film for Blister Packing Of Other Plastics	37	37	37	37.25
			39209990	Plates..., Of Other Plastics, Not Reinforced, Etc, Nes	73.96	73.96	73.96	73.74
	848220	Tapered Roller bearings (Wind Turbine Components)	**84822000**	Tapered Roller Bearings, Including Cone and Tapered Roller Assemblies	37	37	37	37.25
	848230	Spherical Roller bearings (Wind Turbine Components)	**84823000**	Spherical Roller Bearings	37	37	37	37.25
	848240	Needle Roller bearings (Wind Turbine Components)	**84824000**	Needle Roller Bearings	37	37	37	37.25
	848250	Other Cylindrical Roller bearings	**84825000**	Other Cylindrical Roller Bearings (Excl. Needle)	37	37	37	37.25

Product Category	Commodity Code (6 digit HS Code)	Commodity Descriptions	Commodity Code (8 digit HS Code)	Commodity Descriptions	Total Tax Incidence (TTI) 2022-23	Total Tax Incidence (TTI) 2023-24	Total Tax Incidence (TTI) 2024-25	Total Tax Incidence (TTI) 2025-26
		(Wind Turbine Components)						
	848280	Other Ball or Roller Bearings (Wind Turbine Components)	**84828000**	Ball or Roller Bearings (Incl. Combined Ball/Roller Bearings), Nes	58.6	58.6	58.6	58.4
	848340	Gears and Gearing (Other than Tooth) (Wind Turbine Components)	**84834000**	Gears and gearing; ball or roller screws; gear boxes and other speed changers...	26.2	26.2	26.2	26.9
	730820	Towers and Lattice Masts (Wind Energy)	**73082000**	Towers and Lattice Masts Of Iron Or Steel	58.6	58.6	58.6	58.4
	841011	Hydraulic turbines (micro < 1 MW)	**84101100**	Hydraulic Turbines and Water Wheels, Of A Power <=1000kw	26.2	26.2	26.2	25.75
	841012	Hydraulic turbines (small 1 -10 MW)	**84101200**	Hydraulic Turbines and Water Wheels, Of A Power 1000-10000kw	26.2	26.2	26.2	25.75
	841013	Hydraulic turbines (large >10 MW)	**84101300**	Hydraulic Turbines and Water Wheels, Of A Power > 10MW	26.2	26.2	26.2	25.75
	841090	Parts for Hydraulic Turbines	**84109000**	Parts of Hydraulic Turbines, Water Wheels, and Regulators	26.2	26.2	26.2	25.75
Solar products	**854140**	Solar cell; light emitting diode; other photosensitive semiconductor device	**85414100**	Photosensitive semi-conductor devices, including Light-emitting diodes (LED)	31	31	31	31.5
			85414200	Photovoltaic cells not assembled in modules or made up into panels	25	25	25	25.75

Product Category	Commodity Code (6 digit HS Code)	Commodity Descriptions	Commodity Code (8 digit HS Code)	Commodity Descriptions	Total Tax Incidence (TTI) 2022-23	Total Tax Incidence (TTI) 2023-24	Total Tax Incidence (TTI) 2024-25	Total Tax Incidence (TTI) 2025-26
			85414300	Photovoltaic cells assembled in modules or made up into panels	26.2	26.2	26.2	26.9
			85414900	Other Photosensitive semi-conductor devices, light-emitting diodes (LED) NES	31	31	31	31.5
	850239	Generator set that relies on renewable energy (RE) to produce electricity	**85023900**	Generating sets (excl. wind-powered), nes	26.2	26.2	26.2	26.9
	841919	Solar water heaters	**84191900**	Other Instantaneous or Storage Water Heaters, Non-Electric, Nes	31.5	31.5	31.5	31.5
	850440	Solar inverter, converter, regulated power supply	**85044010**	Mobile battery charger (less than 6V)	58.6	58.6	58.6	58.4
			85044020	UPS/IPS (Capacity upto 2000 VA)	43	43	43	43
			85044030	Voltage stabilizer (capacity upto 2,000 VA)	43	43	43	43
			85044090	Other Static converters	37	37	37	37.25
	854370	Solar power station	**85437010**	Remote control for electronic and electrical apparatus	58.6	58.6	58.6	58.4
			85437020	Electronic talking dictionary	26.2	26.2	26.2	26.9
			85437030	Electronic insects repelling devices	58.6	58.6	58.6	58.4
			85437040	Electric/Electronic access control	31	31	31	31.5
			85437090	Other machines & appa., Excl. Remote control for electronic and electrical appa.	37	37	37	37.25
	850720	Lead-acid cell for solar energy	**85072010**	Sealed (capacity 85 amp or less) imported by VAT registered	58.6	58.6	58.6	58.4

Product Category	Commodity Code (6 digit HS Code)	Commodity Descriptions	Commodity Code (8 digit HS Code)	Commodity Descriptions	Total Tax Incidence (TTI) 2022-23	Total Tax Incidence (TTI) 2023-24	Total Tax Incidence (TTI) 2024-25	Total Tax Incidence (TTI) 2025-26
				manufacturing industries				
			85072090	Other Lead Acid Accumulators	89.32	89.32	89.32	89.08
	940540	Solar-related lighting device	**94054110**	Photovoltaic design. use solely with light-emitting diode (LED) light sources	31	31	31	31.5
			94054190	Photovoltaic design. use solely with light-emitting diode (LED) light sources	127.72	127.72	127.72	127.43
	901390	Solar heliostat parts	**90139010**	Parts and Accessories Of Lasers And Optical Devices, Nes, Of 90.13	31	31	31	31.5
			90139090	Parts and Accessories Of Lasers And Optical Devices, Nes, Of 90.13	31	31	31	31.5
	280461	Polysilicon	**28046100**	Silicon Containing by Weight >=99.99% Silicon	37	37	37	31.5
	732119, 732111	Solar Cooking Stoves	**73211100**	Cooking Appliances, Plate Warmers, For Gas Fuel... Of Iron or Steel	89.32	89.32	89.32	89.08
			73211900	Cooking appliances & plate warmers: Other, including appliances for solid fuel	58.6	58.6	58.6	58.4
	732189	Wood Pellet Cooking Stoves	**73218910**	Stoves, ranges, grates, cookers appliances, Other, including appliances for solid fuel	37	37	37	37.25
			73218990	Stoves, ranges, grates, cookers appliances, Other, including appliances for solid fuel	58.6	58.6	58.6	58.4
	903210	Thermostats	**90321000**	Thermostats	26.2	26.2	26.2	26.9

Product Category	Commodity Code (6 digit HS Code)	Commodity Descriptions	Commodity Code (8 digit HS Code)	Commodity Descriptions	Total Tax Incidence (TTI) 2022-23	Total Tax Incidence (TTI) 2023-24	Total Tax Incidence (TTI) 2024-25	Total Tax Incidence (TTI) 2025-26
Biomass Energy products	**440130**	Sawdust, waste, and other biomass	**44013100**	Wood pellets	10	10	10	10
			44013200	Sawdust and wood, Wood briquettes	31	31	31	31.5
			44013900	Sawdust and wood waste and scrap Other than Wood pellets	10	10	10	10
	841620	Gas burners, burners, etc.	**84162000**	Other Furnace Burners for Solid Fuel Or Gas (Incl. Combination Burners)	26.2	26.2	26.2	26.9
	850220	Natural gas power generation unit, generator	**85022000**	Generating sets with spark-ignition internal combustion piston engines	26.2	26.2	26.2	26.9
	840510	Producer gas or water gas generators acetylene	**84051000**	Producer Gas or Water Gas Generators; Acetylene Gas Generators, etc.	26.2	26.2	26.2	26.9
	840590	Parts of prod gas or wat gas gen,acetylene gas	**84059000**	Parts of Producer Gas Or Water Gas Generators, etc.	26.2	26.2	26.2	25.75
	847930	Granulator; wood extruder; biomass mill, etc.	**84793000**	Machinery for Treating Wood Or Cork, Having Individual Functions	26.2	26.2	26.2	26.9
	840790	Biogas engine	**84079010**	Spark-Ignition Recipro.N/Rotary Intl Combustion Engines for Industrial Use	26.2	26.2	26.2	26.9
			84079090	Spark-Ignition Reciprocating/Rotary Intl. Combustion Engines, Nes	53.6	53.6	53.6	53.4
	220710	Un-denatured Ethyl Alcohol	**22071000**	Undenatured Ethyl Alcohol, Of Alcoholic Strength >=80% By Vol.	73.6	73.6	73.6	73.4
	220720	De-natured Ethyl Alcohol	**22072000**	Ethyl Alcohol and Other Denatured Spirits Of Any Strength	73.6	73.6	73.6	73.4

Source: NBR, 2022, 2023, 2024a, 2025

Annex B: Methodology: A Standard CGE Model for Bangladesh

B.1 Standard CGE Model

This paper employs a single-country, static CGE model developed according to the IFPRI standard (Lofgren et al., 2002) with subsequent modifications. The model follows the SAM disaggregation of factors, activities, commodities, and institutions. The model, therefore, captures the economy-wide interactions among producers, households, the government, and the rest of the world through a system of simultaneous equations based on neoclassical microeconomic theory.

Activities, Production, and Factor Markets: In the CGE model, a representative firm (represented by an activity) in each sector maximizes profits subject to its production technology. The sectoral output follows a Leontief production function of value-added and intermediate inputs, assuming no substitution between them. Each industry's value added is composed of composite labor and composite capital, following a CES specification. Different categories of labor are combined using a CES technology with imperfect substitutability across types. Composite capital is a CES combination of capital categories. It is assumed that intermediate inputs are perfectly complementary. They are combined following a Leontief production function.

Institutions: In the CGE model, institutions are represented by households, enterprises, the government, and the rest of the world. Household incomes come from labor income, capital income, and transfers received from other agents. Subtracting direct taxes yields a household's disposable income. Household savings are a linear function of disposable income, which allows the marginal propensity to save to differ from the average propensity.

Corporate income consists of its share of capital income and of transfers received from other agents. Deducting business income taxes from total income yields the disposable income of each type of business. Likewise, business savings are the residual that remains after subtracting transfers to other agents from disposable income.

The government draws its income from household and business income taxes, taxes on products and imports, and other production taxes. Income taxes for both households and businesses are described as a linear function of total income. The current government budget surplus or deficit (positive or negative savings) is the difference between its revenue and its expenditures. The latter consists of transfers to agents and current expenditures on goods and services.

The rest of the world receives payments for the value of imports, part of the income of capital, and transfers from domestic agents. Foreign spending in the domestic economy consists of the value of exports and transfers to domestic agents. The difference between foreign receipts and spending is the amount of rest-of-the-world savings, which equals the current account balance in absolute value but has the opposite sign.

Commodity Markets: The demand for goods and services, whether domestically produced or imported, consists of household consumption demand, investment demand, demand by government, and demand as transport or trade margins. It is assumed that households have Stone–Geary utility functions (which give rise to the Linear Expenditure System). Investment demand includes both gross fixed capital formation (GFCF) and changes in inventories. Nested constant-elasticity-of-substitution (CES) functions represent producers' supply behavior. On the upper level, aggregate output is allocated to individual products; on the lower level, the supply of each product is distributed between the domestic market and exports. The model departs from the pure form of the small-country hypothesis. A local producer can increase his share of the world market only by offering a price that is more advantageous than the (exogenous) world price. The ease with which his share can be increased depends on the degree of substitutability of the proposed product for competing products; in other words, it depends on the price-elasticity of export demand. Commodities demanded on the domestic market are composite goods, combinations of locally produced goods and imports. A CES aggregator function represents the imperfect substitutability between the two. Naturally, for goods with no import competition, the demand for the composite good is the same as the demand for the domestically produced good. The system requires equilibrium between supply and demand for each commodity in the domestic market. The sum of supplies of every commodity made by local producers must equal domestic demand for that locally produced commodity. Finally, supply to the export market of each good must be matched by demand. Also, there is an equilibrium between total capital demand and its available supply. However, the model assumes both fixed and flexible wage rates for labor under different closure conditions.

Macroeconomic Balances: The CGE model includes three macroeconomic balances: the (current) government balance, the external balance (the current account of the balance of payments, which includes the trade balance), and the Savings-Investment balance.

B.2 A Brief Description of the Social Accounting Matrix (SAM) 2022

The Social Accounting Matrix (SAM) used in this study is the 2022 Bangladesh SAM, developed by the International Food Policy Research Institute (IFPRI, 2024) as part of the Nexus Project. The SAM provides a comprehensive and internally consistent snapshot of the Bangladesh economy for the base year 2022, capturing the circular flow of income and expenditure across all major economic agents and markets. It encompasses 86 activities and 86 corresponding commodities, disaggregated into 35 agricultural activities, 39 industrial activities, including fossil fuel sectors such as coal, crude oil, and natural gas, and 12 service activities, thereby enabling a detailed sectoral analysis of the economy. The factors of production account distinguish 13 factor types, comprising eight labor categories differentiated by location (rural and urban) and education level (uneducated, primary, secondary, and tertiary), alongside five capital categories specific to crops, livestock, mining, and other sectors, as well as crop land. The household account is disaggregated into 15 representative household groups, classified by rural farm, rural nonfarm, and urban locations, and further divided into five expenditure quintiles within each group, allowing for a granular assessment of the distributional and welfare impacts of economic shocks across the income spectrum. The remaining accounts cover transaction costs, enterprises, government, taxes, savings and investment, changes in stocks, and the rest of the world. This rich disaggregation of sectors, factors, and households makes the 2022 Bangladesh SAM particularly well-suited for analyzing the economy-wide, sectoral, and household welfare effects of fossil-fuel price shocks within the CGE modeling framework employed in this study.

Table B1: Description of Bangladesh SAM for 2022

Set	Description of Elements
Activity (86)	**Agricultural Activities (35):** Maize, Sorghum + millet, Rice, Wheat + barley, Other cereals, Pulses, Groundnuts, Other oilseeds, Cassava, Irish potatoes, Sweet potatoes, Other roots, Leafy vegetables, Other vegetables, Sugarcane, Tobacco, Cotton + fibers, Nuts, Bananas + plantains, Other fruits, Tea, Coffee, Cocoa, Cut flowers, Rubber, Other crops, Cattle, Raw milk, Poultry, Eggs, Sheep + goats, Other livestock, Forestry, Aquaculture, Capture fisheries **Industrial Activities (39):** Coal, Crude oil, Natural gas, Other mining, Meat, Fish + seafood, Dairy, Fruits + vegetables, Fats + oils, Maize milling, Sorghum + millet milling, Rice milling, Wheat + barley milling, Other grain milling, Sugar refining, Coffee processing, Tea processing, Other foods, Animal feed, Beverages, Tobacco, Cotton yarn, Textiles, Clothing, Leather + footwear, Wood, Paper, Petroleum, Chemicals, Non-metal minerals, Metals + metal products, Machinery, Equipment, Vehicles, Other manufacturing, Electricity + gas, Water supply + sewage, Construction **Services Activities (12):** Wholesale + retail trade, Transportation + storage, Accommodation, Food services, Information + communication, Finance + insurance, Real estate activities, Business services, Public administration, Education, Health + social work, Other services
Commodity (86)	**Agricultural Commodities (35):** Maize, Sorghum + millet, Rice, Wheat + barley, Other cereals, Pulses, Groundnuts, Other oilseeds, Cassava, Irish potatoes, Sweet potatoes, Other roots, Leafy vegetables, Other vegetables, Sugarcane, Tobacco, Cotton + fibers, Nuts, Bananas + plantains, Other fruits, Tea, Coffee, Cocoa, Cut flowers, Rubber, Other crops, Cattle, Raw milk, Poultry, Eggs, Sheep + goats, Other livestock, Forestry, Aquaculture, Capture fisheries **Industrial Commodities (39):** Coal, Crude oil, Natural gas, Other mining, Meat, Fish + seafood, Dairy, Fruits + vegetables, Fats + oils, Maize milling, Sorghum + millet milling, Rice milling, Wheat + barley milling, Other grain milling, Sugar refining, Coffee processing, Tea processing, Other foods, Animal feed, Beverages, Tobacco, Cotton yarn, Textiles, Clothing, Leather + footwear, Wood, Paper, Petroleum, Chemicals, Non-metal minerals, Metals + metal products, Machinery, Equipment, Vehicles, Other manufacturing, Electricity + gas, Water supply + sewage, Construction **Services Commodities (12):** Wholesale + retail trade, Transportation + storage, Accommodation, Food services, Information + communication, Finance + insurance, Real estate activities, Business services, Public administration, Education, Health + social work, Other services
Factors of Production (13)	Labor - rural uneducated, Labor - rural primary, Labor - rural secondary, Labor - rural tertiary, Labor - urban uneducated, Labor - urban primary, Labor - urban secondary, Labor - urban tertiary, Crop land, Capital – crops, Capital – livestock, Capital – mining, Capital - other
Households (15)	Rural - farm q1, Rural - farm q2, Rural - farm q3, Rural - farm q4, Rural - farm q5, Rural - nonfarm q1, Rural - nonfarm q2, Rural - nonfarm q3, Rural - nonfarm q4, Rural - nonfarm q5, Urban - q1, Urban - q2, Urban - q3, Urban - q4, Urban - q5
Other Accounts (7)	Transaction costs, Enterprises, Government, Taxes, Savings-investment, Change in stocks, Rest of world

Source: International Food Policy Research Institute (2024), 2022 Social Accounting Matrix for Bangladesh: A Nexus Project SAM

B.3 The Structure of the Bangladesh Economy

Table B2 presents the structure of production and trade in Bangladesh in 2022, highlighting the relative importance of different sectors in GDP, exports, and imports, as well as their trade intensities. Services dominated the economy, accounting for 53% of GDP, but played a limited role in external trade, contributing only 13.2% of total exports and 16.4% of total imports. This indicates that most service activities were domestically oriented, with relatively low export and import penetration. Within services, transportation and storage stood out as the most trade-exposed subsector, accounting for 12.8% of total imports and recording an imports-to-demand ratio of 18.7%, reflecting Bangladesh's significant dependence on imported transport services.

Table B2: Structure of Production and Trade in Bangladesh (2022)

	Share of total (%)			Exports/output (%)	Imports/demand (%)
	GDP	Exports	Imports		
All sectors or commodities	100	100	100	6.8	8.6
Agriculture	11.5	0.7	13.9	0.5	10.1
Crops	5.7	0.2	13.8	0.4	22.4
Livestock	1.8	0	0	0	0.1
Forestry	1.5	0	0	0	0
Fisheries	2.6	0.5	0.1	1.3	0.4
Industry	35.5	86.1	69.7	10.8	10.7
Mining	1.6	0	5.1	0	22.8
Manufacturing	22.9	86.1	64	16.1	13.8
Processed foods	2.8	0.2	10.4	0.2	12.8
Beverage and tobacco	0.5	0.3	0.1	1.5	0.6
Textiles, clothing, and footwear	8	67.7	13.8	44.3	16.4
Wood and paper products	0.7	0	1.3	0.2	6.4
Chemicals and petroleum	0.7	0	18.6	0	32.3
Non-metal minerals	3.1	10.7	0	15.6	0
Metals and metal products	1.7	3.7	0	5.8	0
Machinery, equipment, and vehicles	2.5	0	18.5	0	28.9
Other manufacturing	2.8	3.5	1.3	7.5	3.7
Electricity, gas, and steam	1.3	0	0.6	0	2
Water supply and sewage	0.1	0	0	0	0
Construction	9.7	0	0	0	0
Services	53	13.2	16.4	2.4	4.3
Wholesale and retail trade	14.9	0	0	0	0
Accommodation and food services	1.2	1	1.8	3.2	8.1
Transportation and storage	7.5	3.3	12.8	3.9	18.7
Information and communication	1.1	0	0	0	0
Finance and insurance	3.1	0.5	0	1.1	0
Real estate activities	8.5	0	0	0	0
Business services	1.6	1.3	1.4	9.6	13.7
Public administration	2.9	7.2	0.5	22.5	2.7
Education	3.2	0	0	0	0
Health and social work	3.8	0	0	0	0
Other services	5.3	0	0	0	0

Source: International Food Policy Research Institute (2024), 2022 Social Accounting Matrix for Bangladesh: A Nexus Project SAM

In contrast, industry accounted for 35.5% of GDP but 86.1% of exports and 69.7% of imports, underscoring its central role in Bangladesh's integration into global markets. Within the industry, manufacturing was the key driver, accounting for 22.9% of GDP, generating 86.1% of total exports, and absorbing 64% of imports. Textiles, clothing, and footwear alone accounted for 67.7% of exports and exhibited a very high export intensity of 44.3%, reflecting Bangladesh's strong specialization in this subsector. Non-metal minerals emerged as the second-largest export subsector, accounting for 10.7% of total exports and an export intensity of 15.6%. Several manufacturing activities were highly import-dependent: chemicals and petroleum accounted for 18.6% of total imports with an imports-to-demand ratio of 32.3%, while machinery, equipment, and vehicles accounted for 18.5% of total imports with an imports-to-demand ratio of 28.9%. Mining, which includes coal and crude oil, contributed nothing to exports but accounted for 5.1% of total imports, with an imports-to-demand ratio of 22.8%, indicating a structural dependence on imported fossil fuels that is directly relevant to the present study. Electricity, gas, and steam also recorded a modest but non-trivial import-to-demand ratio of 2%.

Agriculture contributed 11.5% of GDP but accounted for only 0.7% of export earnings, while accounting for 13.9% of total imports; crops were particularly exposed, with an imports-to-demand ratio of 22.4%, indicating limited international competitiveness. Overall, the table reveals a dual structure in which a service-led domestic economy coexists with an industry-led external sector, with exports heavily concentrated in a narrow range of manufacturing activities and imports dominated by fossil fuels, chemicals, and capital-intensive goods, a structural configuration that renders Bangladesh notably vulnerable to external fossil fuel price shocks.

Table B3 summarises the composition of household income in Bangladesh in 2022, revealing clear differences across income quintiles and between rural and urban households. Overall, capital income was the dominant source, accounting for 52.5% of total household income, with non-agricultural capital alone contributing 51%. Labor income accounted for 38.3% of total household income, with the largest share coming from low-educated workers at 18.8%, followed by highly educated workers at 12.4% and medium-educated workers at 7.1%. Crop land income accounted for 3.2% of total household income. This share was notably higher among the poorest households, reaching 6.4% in Quintile 1 and 6.6% in Quintile 2, reflecting the dependence of low-income rural households on land as a productive asset. Transfer income played a relatively minor role at the aggregate level, with government transfers accounting for 0.9% and remittances from the rest of the world accounting for 5% of total household income.

Across income quintiles, pronounced differences in income composition are evident. Poorer households were far more dependent on labor income, particularly low-skilled labor, which accounted for 44% of income in the lowest quintile, compared with only 8.9% in the richest quintile. As household income increased, reliance on labor income declined sharply, while capital income rose, reaching 63.6% in the top quintile, indicating strong asset-based income concentration among richer households. The share of highly educated labor income also increased with income, from 5.3% in Quintile 1 to 14.6% in Quintile 5, reflecting the close association between higher education and higher household income (Ahmed & Zubayer, 2024; Zubayer et al., 2025).

Rural and urban households exhibited distinct income structures. Rural households derived 21.7% of income from low-educated labor and 2.3% from agricultural capital, compared with 14.6% and 0.3%, respectively, for urban households, reflecting the more agrarian character of rural income sources (also see Rahman et al., 2025). Urban households, by contrast, derived 17.4% of income from highly educated labor, nearly double the rural share of 8.9%, and 57.2% from non-agricultural capital, compared with 46.8% for rural households, indicating the greater importance of skilled employment and nonfarm capital in urban income generation. Remittances from abroad were more significant for rural households, accounting for 6.3% of rural household income, compared with 3.2% for urban households.

Overall, Table B3 highlights pronounced inequality in income sources, with poorer households depending mainly on low-skill labor and crop land, and richer households benefiting disproportionately from non-agricultural capital income and higher-skill employment (see Ahmed & Chowdhury, 2024; Hossain et al., 2026; Raihan et al., 2022a). These structural differences in income composition have important implications for the distributional consequences of fossil fuel price shocks, as households with different income sources are likely to be affected through distinct transmission channels.

Table B3: Household Income Sources in Bangladesh (2022)

	Share of total household income (%)									
	Labor by education level				Crop land	Capital			Transfers	
	All workers	Low educated	Medium educated	High educated		All	Agriculture	Non-agriculture	Government	World
All households	38.3	18.8	7.1	12.4	3.2	52.5	1.5	51	0.9	5
Quantile 1	56.8	44	7.4	5.3	6.4	31.7	3.4	28.4	3	2.1
Quantile 2	53.7	36.6	9.4	7.7	6.6	33.9	2.8	31.2	2.5	3.2
Quantile 3	48.3	27	9.7	11.7	4.8	40.4	2.1	38.3	1.4	5.1
Quantile 4	38.9	19.5	7	12.4	3.4	51.2	1.4	49.8	0.8	5.6
Quantile 5	29.3	8.9	5.8	14.6	1.4	63.6	0.8	62.8	0.3	5.5
Rural households	38.1	21.7	7.4	8.9	5.1	49	2.3	46.8	1.4	6.3
Urban households	38.7	14.6	6.6	17.4	0.3	57.5	0.3	57.2	0.3	3.2

Source: International Food Policy Research Institute (2024), 2022 Social Accounting Matrix for Bangladesh: A Nexus Project SAM

Table B4 provides an overview of household populations, consumption, and spending patterns in Bangladesh in 2022, highlighting disparities across income quintiles and between rural and urban households. The total population was approximately 167.9 million, with rural households comprising 72.8% and urban households 27.2%. Average per capita consumption spending was 172 thousand Taka, with food accounting for 34.8% of this expenditure. In comparison, total per capita spending was higher at 220 thousand Taka, reflecting a national savings rate of 21.2%.

There were marked differences across income quintiles. The poorest quintile accounted for 20% of the population but only 6.4% of total consumption, with a per capita consumption spending of 55 thousand Taka and a high food share of 42.9%, reflecting severely limited purchasing power. Total per capita spending for this group was 65 thousand Taka, with a savings rate of only 15.8%, the lowest among all quintiles, indicating that the poorest households have virtually no financial buffer against income or price shocks. In contrast, the richest quintile also comprised 20% of the population. However, it accounted for 46.9% of total consumption, with per capita consumption spending of 404 thousand Taka, total per capita spending of 520 thousand Taka, and a lower food share of 33.3%, indicating considerably higher discretionary income. The savings rate generally rose with income, from 15.8% in Quintile 1 to a peak of 22.9% in Quintile 3, before stabilizing at around 21–22% in the upper quintiles, suggesting that middle- and upper-income households have greater capacity to absorb economic shocks through savings.

Rural and urban households exhibited distinct consumption and spending profiles. Rural households had a lower per capita consumption spending of 148 thousand Taka and a higher food share of 37% compared with urban households, which recorded per capita consumption spending of 236 thousand Taka and a food share of 31.1%, reflecting lower incomes and a greater proportion of budgets devoted to essential food expenditure in rural areas. Total per capita spending was 178 thousand Taka for rural households and 333 thousand Taka for urban households. The rural savings rate of 16.5% was considerably lower than the urban rate of 27.7%, indicating that rural households face significantly tighter budget constraints and are more financially exposed to adverse price shocks.

Overall, Table B4 highlights pronounced inequality in consumption and spending, with wealthier urban households enjoying higher living standards, lower relative food expenditures, and higher savings rates. In comparison, rural and poorer households face tighter budget constraints and greater vulnerability to fossil fuel price shocks that raise the cost of food and other essential goods.

Table B4: Household Populations and Expenditures in Bangladesh (2022)

	Population		Consumption spending			Total spending	
	Millions of people	Share of total (%)	Share of total (%)	Per capita (1000 Taka)	Food share (%)	Per capita (1000 Taka)	Savings rate (%)
All households	167.9	100	100	172	34.8	220	21.2
Quantile 1	33.6	20	6.4	55	42.9	65	15.8
Quantile 2	33.5	20	10.3	89	38.6	111	20.1
Quantile 3	33.6	20	14.8	127	35.1	165	22.9
Quantile 4	33.6	20	21.6	185	33.5	238	21.5
Quantile 5	33.5	20	46.9	404	33.3	520	21.2
Rural households	122.2	72.8	62.7	148	37	178	16.5
Urban households	45.7	27.2	37.3	236	31.1	333	27.7

Source: International Food Policy Research Institute (2024), 2022 Social Accounting Matrix for Bangladesh: A Nexus Project SAM

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