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# Identifying the Alternative Narrative of LNG Dominated Energy-Mix for the Power Sector

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CENTRE FOR POLICY DIALOGUE

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The present paper titled ***Identifying the Alternative Narrative of LNG Dominated Energy-Mix for the Power Sector*** has been prepared by *Dr Khondaker Golam Moazzem*, Research Director, CPD (moazzem@cpd.org.bd), *Dr Rafat Alam*, Associate Professor, MacEwan University, *Ms Moumita A. Mallick*, former Programme Associate, CPD; and *Mr Abu Saleh Md. Shamim Alam Shibly*, Senior Research Associate, CPD (shibly@cpd.org.bd).

**Series Editor:** *Dr Fahmida Khatun*, Executive Director, CPD.

# Abstract

This study addresses the critical issue of Bangladesh's pursuit of sustained and secure energy amidst its transition from a Least Developed Country (LDC) after 2026 and become a middle-income nation by 2050. The country has committed to different national and international platforms towards a substantial shift to renewable energy, aiming for 40% of its energy mix to be renewable by 2041, yet it is increasingly relying on expensive LNG-based power generation. The associated costs and impacts of this reliance on LNG, including economic, environmental, and social aspects, are examined. The economic burden, evident in significant government expenditures, poses risks to foreign reserves and macroeconomic indicators, potentially destabilising the nation's fiscal balance. Moreover, the environmental implications of LNG, including greenhouse gas emissions and various air pollutants, are discussed, along with potential adverse effects on local ecosystems and communities. The findings underscore the urgency of transitioning to cleaner and more sustainable energy sources to mitigate climate change and avoid potential long-term economic risks associated with fossil fuel infrastructure investments. The study emphasises the immediate expansion of RE as an alternative to ensure a sustainable and resilient energy future, increased domestic gas exploration, and increased efficiency in power generation, transmission, and distribution.

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# Acronyms

| | |
|---|---|
| BAPEX | Bangladesh Petroleum Exploration and Production Company Limited |
| CKt | Circuit Kilometer |
| CM | Cubic Meters |
| $CO_2$ | Carbon Dioxide |
| FSRU | Floating Storage Regasification Unit |
| GHG | Greenhouse Gas |
| HFO | Heavy Fuel Oil |
| HSD | High-Speed Diesel |
| IEPMP | Integrated Energy and Power Master Plan |
| KWh | Kilowatt Hour |
| LCoE | Levelised Cost of Energy |
| LNG | Liquefied Natural Gas |
| LoA | Letter of Acceptance |
| LoI | Letter of Intent |
| MMBtu | Metric Million British Thermal Unit |
| MMcfd | Million Cubic Feet Per Day |
| Mtpa | Million Tonne Per Annum |
| MVA | Mega Volt Amp |
| MW | Megawatts |
| $NO_2$ | Nitrogen Dioxides |
| NOx | Nitrous Oxide |
| $O_3$ | Ozone |
| OTI | Oman Trading International |
| PM | Particulate Matter |
| PSMP | Power System Master Plan |
| RE | Renewable Energy |
| $SO_2$ | Sulphur Dioxide |
| TWh | Terawatt Hour |

## 1. INTRODUCTION

Bangladesh is at a crossroad to its future development journey. Its goal of being a higher middle-income country by 2050 depends on an increased supply of energy that can keep pace with the rising demands due to the economic growth. To ensure sustainable growth — the increased energy supply needs to be sustainable and secure. Besides, the global fight against climate change requires the energy sector growth to be cleaner. Bangladesh, like many other countries, has been undergoing a significant transformation in its energy sector, with an increasing focus on the utilisation of the Liquefied Natural Gas (LNG) as a transition energy source towards a cleaner mix of energy supply in the long run. This shift towards LNG is expected to play a crucial role in shaping the country's energy mix. However, it is essential to critically examine the implications and potential consequences of relying heavily on LNG as a dominant energy source for the power sector.

Historically, Bangladesh has heavily relied on traditional sources such as coal and natural gas to fuel its power generation. However, with the depletion of domestic natural gas reserves and the environmental concerns associated with coal-fired power plants, there has been a shift in the plans of the government towards exploring alternative sources like imported LNG and renewable energy (RE). The government of Bangladesh envisions LNG as a game-changer in meeting the increasing electricity demands of the rapidly growing population and industrial sector. The import of LNG is perceived as a reliable and efficient solution to bridge the demand-supply gap in the power sector. However, the cost associated with the utilisation of LNG remains higher compared to domestic coal or gas-based power plants. Also. The increased dependence on LNG also impacts macroeconomic indicators, society, and the environment. However, the impacts of LNG in Bangladesh are difficult to quantify since no LNG-based power plants are yet in operation.

While the integration of LNG in the power sector holds promise, it is vital to consider its potential drawbacks and associated costs. Economically, significant investments are needed for LNG infrastructure, while price volatility in the global market poses risks. Environmentally, greenhouse gas emissions, air quality, and ecological consequences need careful consideration. Socially, concerns about the impact on the community must be addressed. By understanding these costs, Bangladesh can develop a sustainable energy strategy that balances among economic growth, social equity, and environmental conservation, contributing to a more resilient and climate-conscious energy future.

To comprehensively assess the alternative narrative of the LNG-dominated energy mix for the power sector, this study explores the following areas:

a. Examining the electricity demand-supply gap in Bangladesh and the role of LNG to fill that gap.
b. Assessing the economic impacts of LNG use.
c. Evaluating the possible environmental and social impacts of LNG-based power plants.
d. Discussing the alternative to LNG use.
e. Providing policy suggestions for the way forward.

The study uses literature review, secondary data analysis, and 5 KIIs to fulfill the above objectives.

## 2. CURRENT AND FORECASTED DEMAND AND SUPPLY OF ELECTRICITY

Demand for electricity in Bangladesh is projected to reach 52,000 megawatts (MW) by 2041. 'The Government of Bangladesh has plans to increase power generation beyond expected demand to match the country's economic growth and meet the needs of a growing middle class by raising USD 127 billion in total investments in the power generation sector by 2041. Electricity generation capacity has increased significantly over the last decade, despite poor transmission and distribution infrastructure, and a mismatch between the types of energy needed by existing plants and the fuel mix available'.[1] Private power production units make 47 per cent of the total installed capacity.[2] Electricity is available for 96.2 per cent of the population, up from 20 per cent in 2000.[3] 'Electrical generation capacity has increased from about 5 gigawatts (GW) in 2009 to around 25.5 gigawatts in 2022. Still, the reliability and quality of electricity remain major issues. Improving the supply and reliability of electricity and energy in general, while maintaining affordability is essential to supporting the continued growth of industry and commerce in Bangladesh'.[4]

The table below shows the future power generation plan for Bangladesh.

**Table 1: Power Sector Generation Future Plan**

| Description | Year 2022 | Year 2030 | Year 2041 |
|---|---|---|---|
| Installed capacity (MW) | 25,784 | 40,000 | 60,000 |
| Electricity Demand (MW) | 15,500 | 33,000 | 52,000 |
| Transmission Line (Ckt. KM) | 13,017 | 27,300 | 34,850 |
| Grid Substation Capacity (MVA) | 55,307 | 120,000 | 261,000 |
| Distribution Line (KM) | 619,000 | 660,000 | 783,000 |
| Per capita Power Generation (KWh) | 560 | 815 | 1,475 |
| Access to electricity | 100% | 100% | 100% |

**Source:** Power Division, Government of Bangladesh.

According to the PSMP 2016 and current power generation plan, the demand for electricity in 2023 is expected to be 17,100 MW, and generation is expected to be 27,750 MW. The excessive capacity stands at around 10,000 MW and is expected to increase over the years (Table 2).

**Table 2: Possible Maximum Demand and Net Generation Capacity (MW)**

| Year | Demand | Generation |
|---|---|---|
| 2023 | 17,100 | 27,750 |
| 2024 | 18,500 | 29,005 |
| 2025 | 19,900 | 30,656 |
| 2026 | 21,300 | 35,218 |
| 2027 | 22,800 | 37,245 |

**Source:** BPDB, 2023.

A huge amount of power generation capacity is expected to remain unutilised creating a significant financial burden on the government.

[1] https://www.trade.gov/country-commercial-guides/bangladesh-power-and-energy#:~:text=Demand%20for%20electricity%20in%20Bangladesh,megawatts%20(MW)%20by%202041

[2] Power division, Government of Bangladesh

[3] https://ourworldindata.org/energy/country/bangladesh

[4] https://www.trade.gov/country-commercial-guides/bangladesh-power-and-energy#:~:text=Demand%20for%20electricity%20in%20Bangladesh,megawatts%20(MW)%20by%202041

## 3. THE FUEL MIX OF ELECTRICITY GENERATION

The fuel mix of the Bangladesh electricity sector is one of the major sources of this mismatch as it is heavily based on natural gas. The majority – 60 per cent – of domestic natural gas is utilised for power generation, followed by its use in residential areas, industries, agricultural irrigation, and fertiliser production (IEPMP, 2022). As of July 1, 2022, Bangladesh has identified 29 gas fields with proven and potential recoverable gas reserves amounting to 28.59 trillion cubic feet (The Daily Star, 2022). The current known reserve of domestic natural gas cannot support the energy demand for the future. That is why, the Government of Bangladesh is frantically trying to reduce dependence on domestic natural gas and increase the use of imported liquified natural gas (LNG) as shown in Tables 3 and 4.

**Table 3: Electricity Generation Mix**

| **Fuel/Resource** | **No of plants** | **Installed Capacity (MW)** | **Share (in Per cent)** |
|---|---|---|---|
| Gas | 64 | 11,372 | 46 |
| Heavy fuel oil (HFO) | 65 | 6,492 | 26 |
| High-Speed Diesel (HSD) | 7 | 1,010 | 4 |
| Coal | 5 | 2,692 | 11 |
| Hydro | 1 | 230 | 1 |
| On-grid solar | 10 | 459 | 2 |
| Imported | – | 2,656 | 10 |
| **Total** | **152** | **24,911** | **–** |

**Source:** BPDB (2023).

The installed capacity of gas-based power plants connected to the grid is supposed to experience significant growth, rising from 14.24 TWh in 2000 to a substantial 540.36 TWh in 2050. The capacity of oil-based power plants will show a fluctuating trend, but it should exhibit an overall decline over time. It was 14.56 TWh in 2019 but should decrease to 7.11 TWh in 2050.

The installed capacity of coal-based power plants should experience significant growth from 0.98 TWh in 2012 to 21.8 TWh in 2041. However, it will slightly decline to 21.33 TWh in 2050. The fluctuation suggests a potential shift in energy policy, with the initial reliance on coal followed by a slowdown or gradual phase-out of coal-based power plants. Nuclear power capacity will start in 2030 with 17.04 TWh and remain constant at 17.44 TWh in 2041 and 2050. Until 2021, the Ministry of Power, Energy, and Mineral Resources was reportedly reconsidering plans to shift Bangladesh's fuel mix towards coal – including by generating as much as 50 per cent of the total electricity using coal-based power plants by 2030. However, in a major development, the Bangladesh government scrapped plans to build 10 coal-fired power plants in June 2021, citing unsatisfactory progress of the projects. In June 2022, Japan cancelled funding for the second phase of a coal-fired power plant in Matarbari. In addition, the government is framing a new Power System Master Plan (PSMP) where the use of coal will likely get a lesser priority in the face of pressure from environmental groups and development partners. The government is expanding the use of renewable resources, including solar and wind power. The combined capacity of renewable energy sources (hydro, wind, solar) will grow steadily. And by 2050, the total installed capacity of renewables is projected to reach 39.495 TWh, accounting for about 5.6 per cent of the total power generation capacity of the country.

The government is also considering importing more electricity from the neighbouring countries. The capacity of power plants importing electricity from neighbouring countries will significantly increase from 6.37 TWh in 2019 to 71.1 TWh in 2050. The total installed capacity of all energy sources combined will grow consistently, expanding from 16 TWh in 2000 to 711 TWh in 2050.

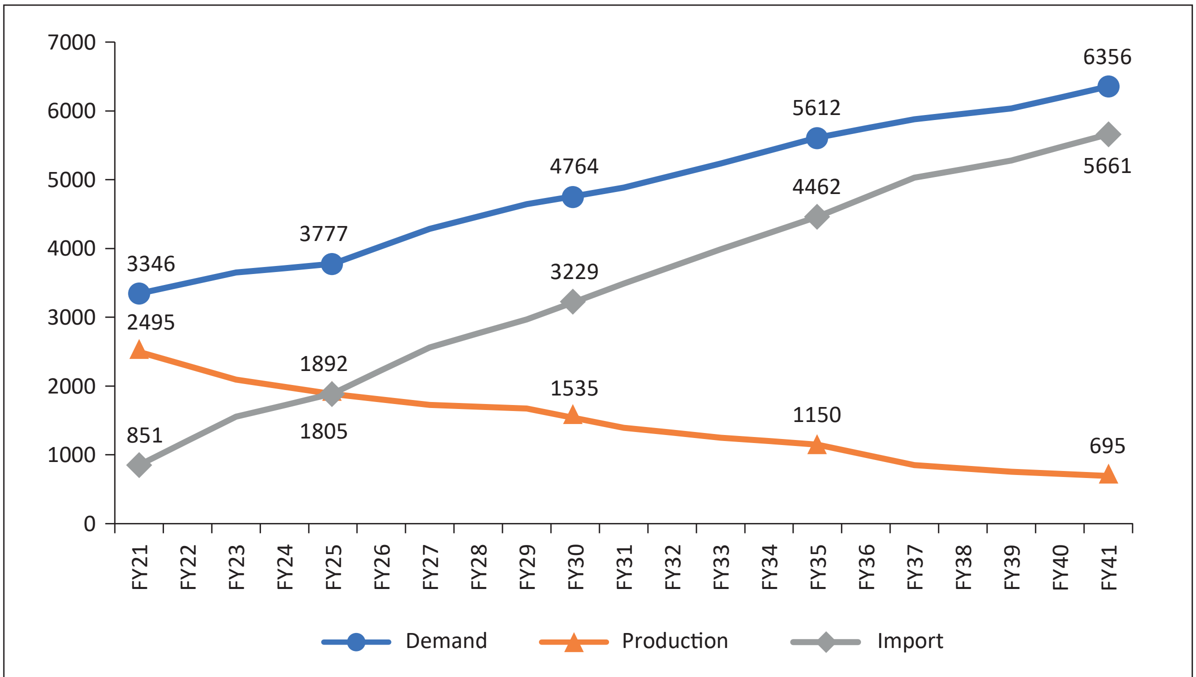
**Table 4: Power Generation Mix in Reference Scenario (IEPMP) (TWh)**

| Fuel/Resource | 2000 | 2012 | 2019 | 2030 | 2041 | 2050 |
|---|---|---|---|---|---|---|
| Gas (Grid) | 14.2 | 27.9 | 51.0 | 117.2 | 309.6 | 540.4 |
| Oil | 1.0 | 5.9 | 14.6 | 8.5 | 4.4 | 7.1 |
| Hydra | 0.8 | 1.0 | 1.8 | 2.1 | 2.2 | 3.6 |
| Coal | – | 1.0 | 0.9 | 17.0 | 21.8 | 21.3 |
| Gas (Captive) | – | 13.2 | 16.4 | 25.6 | 17.4 | 7.1 |
| Import | – | – | 6.4 | 21.3 | 43.6 | 71.1 |
| Nuclear | – | – | – | 17.0 | 17.4 | 14.2 |
| Solar PV (Park) | – | – | – | 2.1 | 4.4 | 7.1 |
| Wind Onshore | – | – | – | 2.1 | 2.2 | 3.6 |
| Wind Offshore | – | – | – | – | 8.7 | 28.4 |
| Solar PV (Roof) | – | – | – | – | 4.4 | 7.1 |
| **Total** | **16.0** | **49.0** | **91.0** | **213.0** | **436.0** | **711.0** |

**Source:** IEPMP and Author's Calculation.

In the Integrated Energy and Power Master Plan (IEPMP), Petrobangla projected the natural gas demand from FY2020–21 to FY2040–41 (Figure 1). According to the document, the demand

**Figure 1: Forecasted Demand, Production, and Import of LNG (in MMcfd)**




**Source:** IEPMP, 2022.

for natural gas is anticipated to increase by 3,010 million cubic feet per day (MMcfd), while the production and supply of natural gas are predicted to decrease by 1,800 MMcfd per day during the same period. This will result in a deficit in the availability of natural gas. Unless an alternative approach is explored and put into action, this gap in gas demand will be filled through the import of LNG. Consequently, it can be reasonably deduced that the imports of LNG will experience a rise of 4,810 MMcfd from FY2020–21 to FY2040–41.

The government is planning to rapidly shift to LNG-based power plants. A total of 10,687 MW of electricity is being planned to be generated from LNG-based power plants from 2023 to 2034 (Annex 1, 2, 3). Currently, 30 power plants with a capacity of 11,609 MW are under construction by the government, joint ventures, and private sector where five power plants equivalent of 3,355 MW (29 per cent) are from LNG based. Additionally, three power plants equivalent of 1,770 MW are under contract signing process where LOI and NOA of those projects have already been issued. Furthermore, the government has already planned to implement 10 LNG projects in their funding and under joint ventures.

It is indicative that Bangladesh has a mix of conventional and non-conventional sources for electricity generation. Gas and Heavy Fuel Oil (HFO) are the two dominant sources of electricity generation, accounting for 44.1 per cent and 24.13 per cent of the total installed capacity, respectively (Table 3). The heavy reliance on gas and HFO raises concerns about economic impacts, as these fuels can be subject to price volatility. Both natural gas and coal are fossil fuels, and their increasing use in power generation will contribute to greenhouse gas emissions, air pollution, and climate change. This dominance must be reduced with further efforts to diversify the energy mix and promote greener alternatives.

## 4. ECONOMIC COST OF INCREASED LNG DEPENDENCY

### 4.1 Infrastructure Costs for LNG Imports

The first economic burden for higher use of imported LNG comes from the substantial funding necessary to develop a comprehensive natural gas process sequence, encompassing the LNG phase. This sequence comprises various stages, including the initial extraction, the liquefaction facility, transportation, and the subsequent re-gasification plant. Table 5 outlines the investment costs associated with an 8 million tonne per annum (Mtpa) LNG process chain, which consists of several key stages: Upstream, Liquefaction, Shipping, and Regasification. This example is taken from Barnett (2010). Initial gas extraction and processing with capital expenses ranging from USD 2–6 billion and unit costs of USD 1–3 per MMBtu represent the early stage of procurement with moderate investment and unit costs. Complex conversion of gas to LNG with capital expenses of USD 6–10 billion and unit costs of USD 3–4.5 per MMBtu dominate investment due to its energy-intensive nature. Transportation of LNG with capital expenses of USD 1–2.5 billion and unit costs of USD 0.8–1.5 per MMBtu has comparatively lower costs. Conversion of LNG back to gas has capital expenses of USD 1–1.5 billion and unit costs of USD 0.4–0.8 per MMBtu. The entire process chain’s investment ranges from USD 10–20 billion, with unit costs per MMBtu ranging from USD 5.2–9.8, where liquefaction is the major cost contributor. The data underscores the significant investment required to establish an LNG process chain. The variation in costs across stages reflects the diverse nature of tasks and infrastructures involved in converting, transporting, and utilising LNG.

**Table 5: Investment Based on an 8 Million Tonne Per Annum LNG Process Chain**

*(in USD, billion)*

| Indicators | Upstream | Liquefaction | Shipping | Regasification | Total |
|---|---|---|---|---|---|
| Capital Expenditure | 2.0–6.0 | 6.0–10 | 1.0–2.5 | 1.0–1.5 | 10–20 |
| Unit Cost (USD / MMBtu) | 1.0–3.0 | 3.0–4.5 | 0.8–1.5 | 0.4–0.8 | 5.2–9.8 |

**Source:** Barnett, (2010).

According to the Integrated Energy and Power Master Plan (IEPMP), the required total investment for natural gas and LNG supply in three time periods: 2022-2030, 2031–2041, and 2042–2050 is estimated to be USD 3,987 million (Table 6). Due to the growing demand for natural gas in Bangladesh, the investment in natural gas and LNG supply is expected to increase significantly in the coming years. The largest investment is estimated to cost USD 2,408 million or 60.4 per cent of the total investment for the Floating Storage Regasification Unit (FSRU). The second largest investment is estimated to cost USD 750 million or 18.8 per cent of the total investment for the onshore terminal. The third largest investment is in the domestic pipeline, which is estimated to cost USD 754 million or 18.9 per cent of the total investment. A domestic pipeline is used to transport natural gas from production facilities to consumption centers. The remaining investment is in compressors and terminals. A compressor is used to increase the pressure of natural gas, while terminals are used to load and unload the LNG.

**Table 6: Required Investment for Natural Gas and LNG Supply**

| Indicators | 2022–2030 | 2031–2041 | 2042–2050 | Total | |
|---|---|---|---|---|---|
| | USD (million) | USD (million) | USD (million) | USD (million) | Per cent |
| Floating Storage Regasification Unit (FSRU) | 344.0 | 688.0 | 1,376.0 | 2,408.0 | 60.4 |
| Onshore terminal | – | 750.0 | – | 750.0 | 18.8 |
| Domestic pipeline | 660.0 | 94.0 | – | 754.0 | 18.9 |
| Compressor | 25.0 | | 25.0 | 50.0 | 1.3 |
| Terminals | 25.0 | – | – | 25.0 | 0.6 |
| **Total** | **1,053.0** | **1,532.0** | **1,401.0** | **3,987.0** | **100.0** |

**Source:** IEPMP, 2022.

## 4.2 Cost of LNG Import

Moazzem et al. (2022) found out Bangladesh's annual average import costs for re-gasified LNG over three fiscal years: 2018–19, 2019-20, and 2020–21. In fiscal year 2018–19, Bangladesh imported approximately 3.28 billion cubic meters of re-gasified LNG. This volume increased significantly to around 5.74 billion cubic meters in 2019–20. There was a further increase in the volume to about 6.12 billion cubic meters in 2020-21. The total import cost for re-gasified LNG in 2018-19 was approximately BDT 121.49 billion. This cost escalated to around BDT 168.73 billion in 2019–20. However, in 2020–21, the total import cost decreased to approximately BDT 159.71 billion. The per unit import cost, calculated as the cost per cubic meter of re-gasified LNG, was BDT 37.02 in 2018–19. This cost decreased to BDT 29.37 in 2019–20. It further decreased to BDT 26.10 Taka in 2020-21.

'Bangladesh signed a long-term contract with Qatargas on 25th September 2017 for 15 years (2018–2032). Under the agreement, Bangladesh can import 29–40 cargo each year. Until June 2021, Bangladesh imported a total of 110 cargos containing 15,347,348 Cubic Meters (CM) of LNG. Bangladesh signed the second long-term contract with OQ Trading Limited (OQT)—officially known as Oman Trading International (OTI)—on 6th May 2018 for 10 years (2019-2028}. Each year Bangladesh can import 16–24 cargos through this contract. A total of 8,401,741 Cubic Meters of LNG in 58 cargos were imported from OQT until June 2021. Apart from long-term contracts, Bangladesh has contracts with 16 companies to import LNG from the spot market. Bangladesh imported its first LNG from the spot market on 25th September 2020. Until June 2021, 11 cargos were imported from the spot market with 1,585,934 cubic meters of LNG. Combining all these three sources, total LNG import has been increasing in Bangladesh. During FY2018–19, the imports were 5,727,618 cubic meters and it became almost double in FY2020–21 (Moazzem & Fahad, 2022).

The data indicates a notable upward trend in both the volume of re-gasified LNG imported and the total import costs from 2018–19 to 2019–20. 'Per unit LNG import cost, was about 24 times over Bangladesh's national company production and 11 times IOC production (Moazzem & Fahad, 2022). This is a huge cost increase when shifting from domestic sources to imported LNG. The government is planning to shift to LNG-based power plants at a large scale. If LNG-based electricity is generated at this large scale in the future despite having lower possible demand than the generation capacity, the financial burden and fiscal budgetary pressure will be significantly higher and drastic under a higher price volatility.

**Table 7: Annual Average Import Costs for Bangladesh**

| Indicators | FY2018–19 | FY2019–20 | FY2020–21 |
|---|---|---|---|
| Re-gasified LNG Volume (Cubic Meter) | 3,281,525,443.00 | 5,744,875,153.00 | 6,119,240,305.00 |
| Total Import Costs (in BDT) | 121,489,018,074.00 | 168,727,998,562.00 | 159,714,569,100.00 |
| Per Unit Import Cost (BDT/ Cubic Meter) | 37.02 | 29.37 | 26.10 |

**Source:** Moazzem and Fahad, (2022).

## 4.3 Volatility in LNG Prices

The global natural gas market has been volatile in recent years, with prices swinging from highs to lows. The recent volatility has been driven by a number of factors, including the war in Ukraine, weather conditions, and maintenance outages at LNG export terminals. The volatility in the natural gas market is likely to continue in the coming years, and countries need to diversify their natural gas supplies and invest in energy efficiency measures to manage the risks (World Bank, 2023).

**Table 8: Price in Nominal US Dollars**

| Year | Liquefied Natural Gas, Japan (in USD /mmbtu) |
|---|---|
| 2020 | 8.3 |
| 2021 | 10.8 |

*(Table 8 contd.)*

*(Table 8 contd.)*

| Year | Liquefied Natural Gas, Japan (in USD /mmbtu) |
|---|---|
| 2022 | 18.4 |
| 2023f | 18.0 |
| 2024f | 16.0 |

**Source:** World Bank Pink Sheet.

**Note:** 'f' indicates the forecasted price.

In 2020, the price of LNG was USD 8.3 per MMBtu (as mentioned in Table 8 above). The price increased to USD 10.8 per MMBtu in 2021, indicating a significant year-on-year price rise. The price further escalated to USD 18.4 per MMBtu in 2022, showing a substantial increase compared to the previous years. For the following years, in 2023 (forecasted), the price is expected to be USD 18 per MMBtu and in 2024 (forecasted), the price is expected to decrease slightly to USD 16 per MMBtu.

It was observed in 2021, that due to the soaring LNG prices in the spot market, the government stopped importing LNG for the time being. The prices in the spot market increased to USD 35.89 per MMBTU in October 2021 from USD 7 per MMBTU in March 2021. Higher dependency and further concentration of LNG in the energy mix causes significant fiscal budgetary consequences. The volatility in the LNG market makes fiscal management difficult and makes the economy prone to vulnerability.

## 4.4 Macroeconomic Impact[5]

Macroeconomic impact of LNG dependency is one of the principal arguments to reduce LNG dependency. Since the Russia-Ukraine war, global LNG markets have experienced a period of extreme volatility. However, LNG price volatility began well before the Russian invasion and will have longer-term ramifications. 'Europe's plan to increase non-Russian LNG imports by 38.9 million tonnes of LNG—will necessarily require pulling existing LNG capacity from elsewhere, rather than simply soaking up new LNG supply. LNG demand in China and India will also grow by 8 per cent each in 2022 and will remain high for the future years. It will tighten inter-regional competition for LNG and cargoes'. Significant new LNG supply capacity is not expected online until the middle of the decade.[6]

As a result of extreme price fluctuations since 2018, developing countries, in particular, have faced difficulty securing fuel supplies, causing fuel and power shortages. Bangladesh has ramped up LNG imports since 2018. The government initially tried to buffer the increase in costs through subsidies, which have jumped from USD 936 million to USD 2.33 billion since FY2018 according to the Finance Division of the GoB. But the subsidy burden had become too much to bear. Amidst the rising fuel prices and subsidy burden, the government resorted to austerity measures. In 2019 it raised the domestic prices of diesel by 42.5 per cent to BDT 114; of kerosene, by the same percentage to the same price; octane, by 51.6 per cent to BDT 135; and petrol by 51.1 per cent to BDT 130.95. These spikes were the highest in nearly 20 years, levelling the prices with those of other Asian countries like China, India, and Nepal. Subsequently, the regulators proposed

[5]This section is written using Bhowmick and Ghosh (2022) and Reynolds (2022).

[6]Reynolds, Sam, 'Now is not the time to build more LNG import terminals in Asia', Working paper, Institute for Energy Economics and Financial Analysis.

another 50 per cent tariff increase in gas prices in 2021, along with a 66 per cent increase in power prices, sparking protests.

The energy price hike has ballooned the inflation rate to 7.56 per cent in June 2022 against approximately 5.36 per cent around the same time the previous year—the highest inflation rate in nine years. Indeed, Bangladesh's inflation rate has been consistently rising since January 2021. The fuel price rise had a strong impact on input costs, and hence the prices of a host of imported and domestic commodities. While much of the inflation is seen in transport, communication, clothing and footwear products, food inflation is also particularly significant at 8.38 per cent in June 2022. Increase in prices of fertilisers and petroleum products has further increased transportation and mechanisation costs, thus causing a surge in the prices of agricultural products. According to Moazzem et al. (2022), consumer spending on non-food and food items increased by at least 13.19 per cent and 17.4 per cent due to the price hike of diesel alone. This cost-push inflation, along with the further depreciation of the Bangladeshi Taka (BDT), put additional pressure on the poor and vulnerable sections of society least responsible for decisions to import higher levels of expensive fossil fuels.

Bangladesh spends around BDT 40,000 crore annually (Mehedi, 2023) from foreign reserves to import LNG let alone the capacity charge associated with LNG-based power generation. This huge government expenditure puts the foreign reserve and the future energy generation plan at risk and impacts other macroeconomic indicators. The high expenditure negatively affects the government's fiscal balance. The formation of reliable national budgets also becomes more difficult. There is a strong causal link between the economy's fiscal balance and current account balance. An empirical investigation in 2021 finds unidirectional causation starting from the fiscal deficit to the trade deficit, and hence the current account deficit in the long-term. This phenomenon is typically true for developing consumption-driven economies like Bangladesh. As the country holds excess demand levels, which necessitate increased imports to match the consumer's needs, and further drives inflation—the commodities thus being produced domestically often become less competitive in global export markets. The over reliance on imported fuel in this way makes many of the macroeconomic indicators unstable and puts the economy at risk and vulnerability.

## 4.5 Energy Security

One of the major concerns with over reliance on imported LNG is the reduction in domestic energy security. Bangladesh's future plan of LNG based power production may provide short term energy security. In the short term, as Bangladesh's natural gas reserves have been depleting rapidly due to increased consumption—LNG imports will help to bridge the energy gap, ensuring a stable supply of power in the short-term. LNG will also provide diversification in the energy mix by reducing dependence on a single energy source, promoting energy security in the face of domestic gas shortages.

But this short-term security is at the expense of long-term insecurity. LNG prices are subject to global market dynamics, which can be highly volatile. The volatility of these prices can present challenges in predicting and managing energy costs over extended periods. Long-term contracts tied to high prices can pose challenges to energy affordability in the long run. The terms of LNG contracts, including pricing mechanisms and duration, significantly impact the stability of energy prices. Long-term contracts may provide price stability, but they can become burdensome if global LNG prices rise substantially. Bangladesh's reliance on LNG imports exposes it to geopolitical vulnerabilities, as LNG supply chains are influenced by international relations. Any political disruptions or conflicts in the LNG supplier countries can disrupt energy security. Global LNG markets can experience fluctuations due to factors like supply-demand imbalances, changes in export policies of LNG-producing countries, and shifts in global energy demand patterns. These market fluctuations can add further insecurity to Bangladesh's economy and long-term growth.

## 5. ENVIRONMENTAL AND SOCIAL IMPACTS

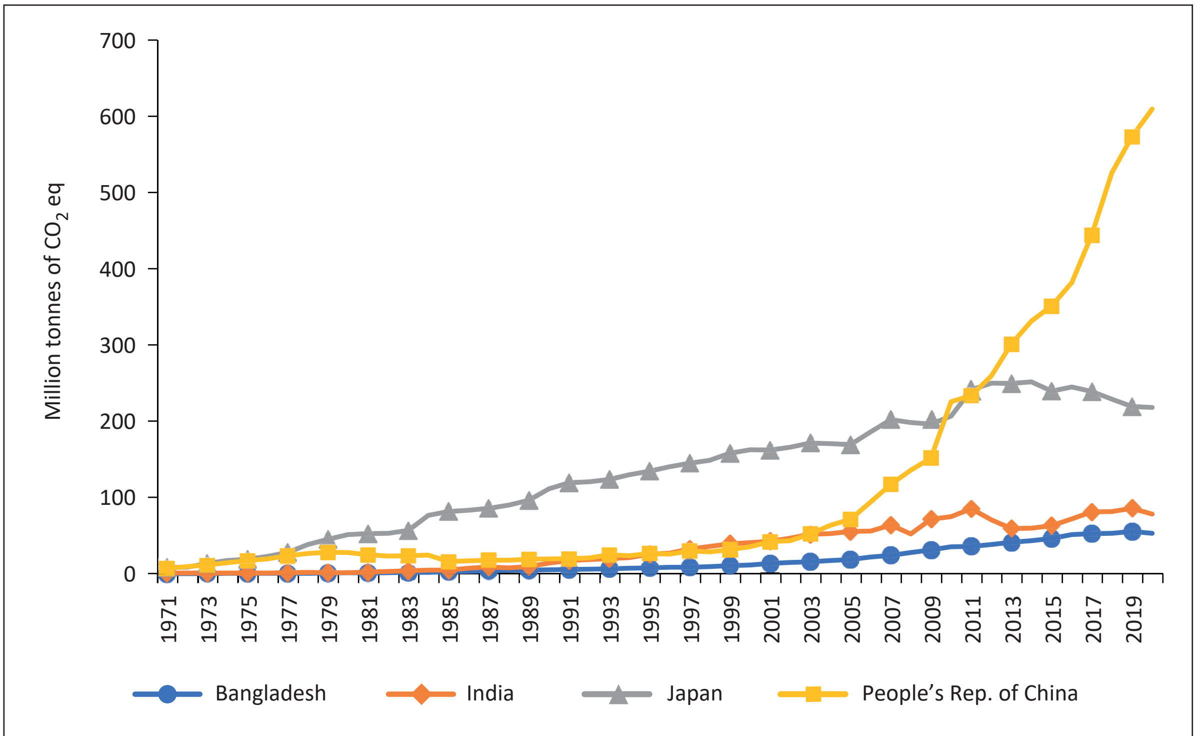
### 5.1 Carbon Dioxide ($CO_2$) Emissions from LNG Power Plants

According to the International Energy Agency, in 2021, fossil fuels retained their significant share of 80 per cent of the total energy supply (TES), globally. Oil accounted for roughly 30 per cent of the TES in the fossil fuel category, with coal accounting for 27 per cent and natural gas accounting for 24 per cent. Coal accounted for the majority of worldwide emissions resulting from fuel combustion, constituting 44 per cent of the overall amount. Oil and natural gas were the subsequent sources of emissions, with oil contributing 32 per cent and natural gas accounting for 22 per cent.

The data presented in Figures 2, 3, and 4 demonstrates that across the four countries – Bangladesh, India, Japan, and China—the lowest levels of greenhouse gas emissions originated from gas combustion over the entire period. Conversely, the highest levels of greenhouse gas emissions from coal combustion were observed in these same countries during the same timeframe.

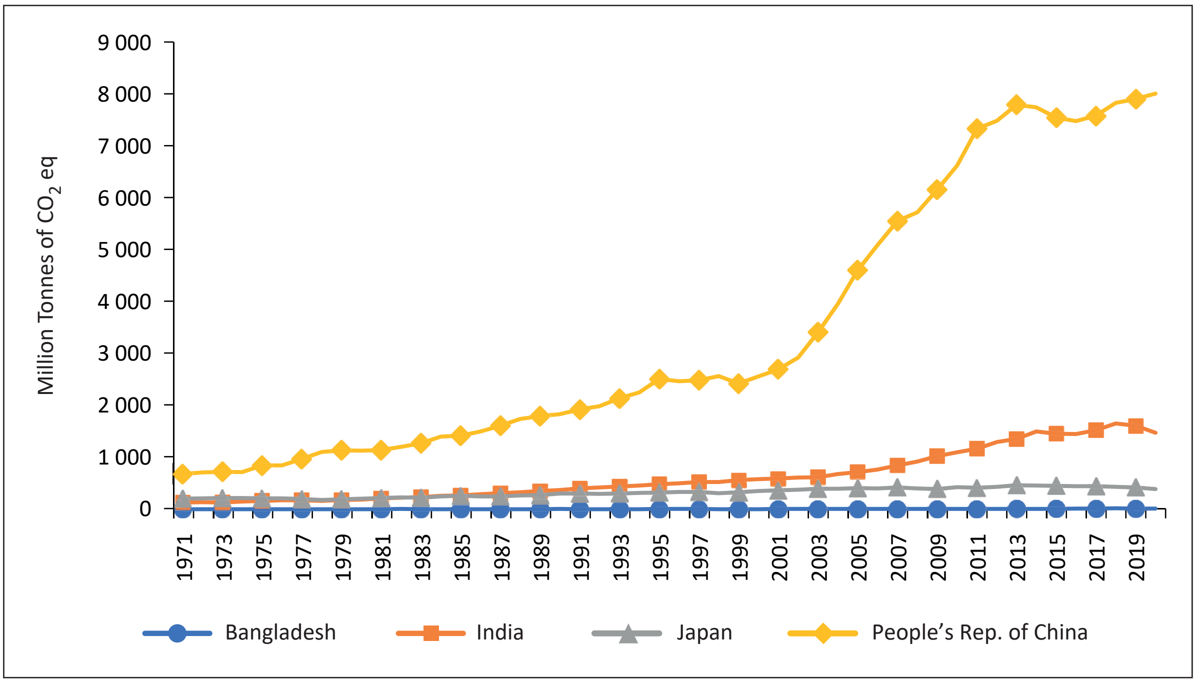
From 1971 to 2019, China recorded an 8,143 per cent increase in greenhouse gas emissions due to gas combustion. Likewise, during this same timeframe, Japan witnessed a significant 2,441 per cent rise in these emissions. India, over the identical period, experienced a substantial 7,750 per cent

**Figure 2: Greenhouse Gas Emissions from Gas (million tonnes of $CO_2$ eq)**



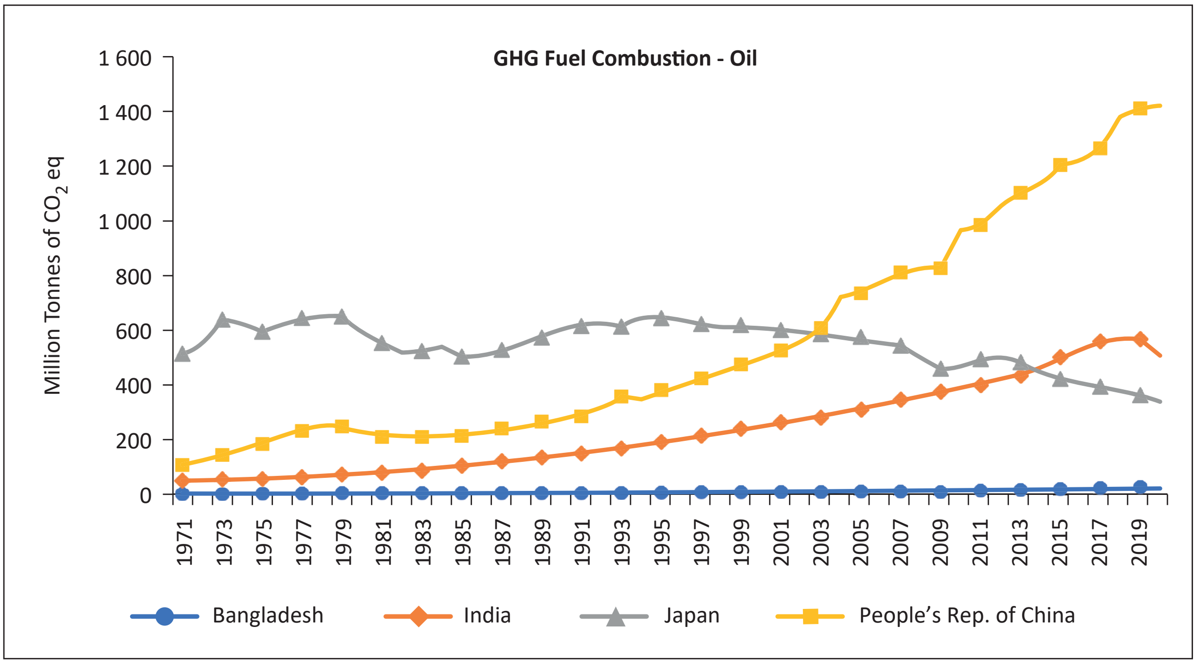

**Source:** IEA.

**Figure 3: Greenhouse Gas Emissions from Coal (million tonnes of $CO_2$ eq)**




**Source:** IEA.

**Figure 4: Greenhouse Gas Emissions from Oil (million tonnes of $CO_2$ eq)**




**Source:** IEA.

surge in greenhouse gas emissions resulting from gas combustion, while Bangladesh observed an extraordinary 17,667 per cent escalation in emissions from the same source (Figure 2).

In the time span from 1971 to 2020, China experienced an astounding 1,084 per cent increase in greenhouse gas emissions from coal combustion. Similarly, Japan saw a significant 91 per cent rise in such emissions. During this identical time frame, India witnessed a substantial 1,049 per cent surge in greenhouse gas emissions from coal combustion, while Bangladesh observed an exceptional 2,175 per cent escalation in emissions from the same source (Figure 3).

Between 1971 and 2020, China saw a 1,217 per cent surge in greenhouse gas emissions resulting from oil combustion. In contrast, during the same period, Japan experienced a notable 34 per cent reduction in such emissions. Over this identical time frame, both India and Bangladesh witnessed a substantial 909 per cent increase in greenhouse gas emissions stemming from oil combustion (Figure 4).

Gas combustion emissions witnessed significant increases across all countries, indicating a reliance on this source for energy generation. Coal combustion emissions exhibited substantial growth, particularly in China, India, and Bangladesh, pointing to their reliance on coal for energy. Oil combustion emissions varied, with China experiencing a surge, Japan reducing emissions, and India and Bangladesh increasing emissions. The substantial increases in GHG emissions from gas, coal, and oil combustion across all countries indicate a significant contribution to global warming.

In a paper by Abrahams et. al. (2015), the authors evaluate the greenhouse gas (GHG) emissions throughout the entire supply chain of the US. LNG is used for electricity generation. It considers production, liquefaction, shipping, regasification, and end-use phases. Comparing these emissions with alternative fuel sources like locally produced coal and natural gas transported from Russia via pipeline, the findings show that the average precombustion life cycle GHGs for exported US LNG after regasification in the importing country amount to 37 g $CO_2$-equiv/MJ[7]. Shipping accounts for approximately 5 per cent of these precombustion emissions. Specifically, life cycle emissions from the US LNG accounts for average 655 g $CO_2$-equiv/kWh[8] for electricity generation. Furthermore, in addition to the emissions from production and combustion, the liquefaction, shipping, and regasification stages contribute an extra 72 g $CO_2$-equiv/kWh to the life cycle emissions of domestic natural gas electricity generation.

'National gas is considered a relatively clean source of energy as compared to that coal from an environmental perspective. But LNG has GHG emissions close to coal. This is because of the extra processes LNG goes through e.g., liquefaction, shipping'.[9] LNG life cycle emissions can be high as 822 g $CO_2e$/kWh (Roman-White, Rai, Littlefield, Cooney, & Skone, 2019), which is even higher than some coal-fired power plants. Moazzem and Fahad (2022) calculated the emissions associated with LNG consumption in power plants. Figure 5 shows the consumption of regasified LNG in power plants, along with associated emissions for the years 2019 to 2024 and forecasted associated emissions for 2022 to 2024.

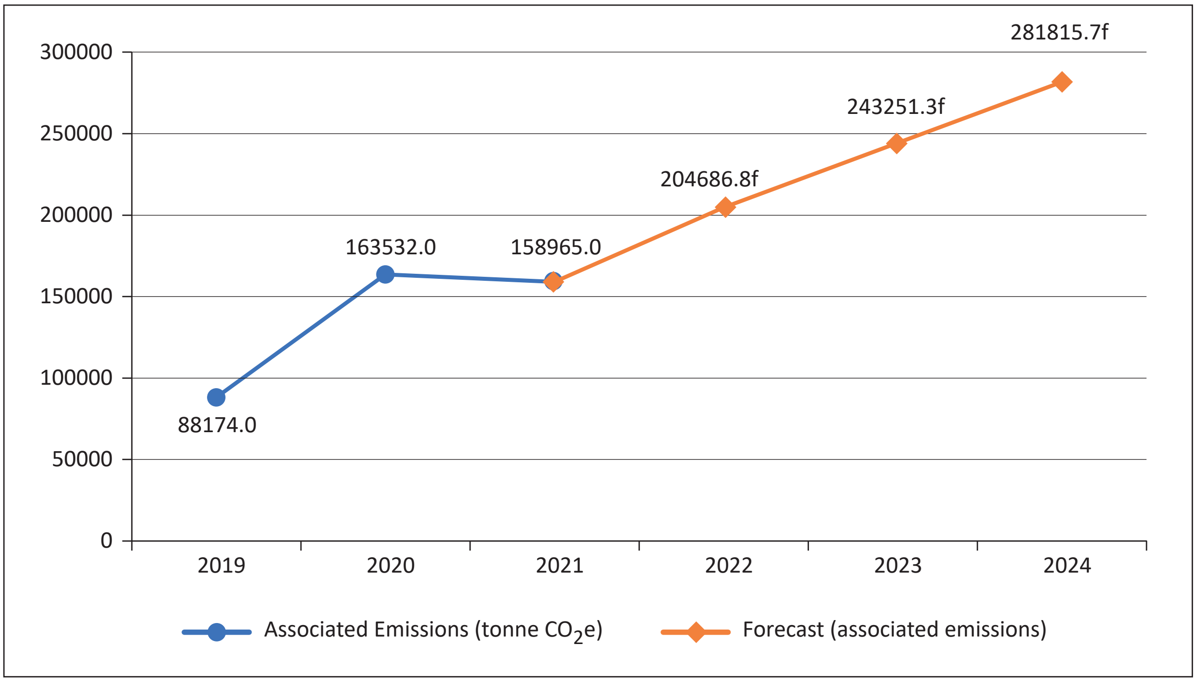
According to Moazzem and Fahad (2022), in the fiscal year 2019, power plants consumed approximately 1.42 billion cubic meters of regasified LNG. This consumption increased significantly to about 2.63 billion cubic meters in 2020. In 2021, consumption will slightly decrease to around 2.56 billion cubic meters. In 2019, the associated emissions with the consumption of regasified LNG in power plants were approximately 88,174 tonnes $CO_2e$. This increased to around 163,532 tonnes $CO_2e$ in 2020. In 2021, associated emissions were approximately 158,965 tonnes $CO_2$. For the years 2022 to 2024, forecasted associated emissions are provided. The forecast for associated

[7]grams of carbon dioxide equivalent per megajoule

[8]grams of carbon dioxide equivalent per kilowatt-hour

[9]Moazzem and Fahad (2022)

**Figure 5: Emissions Associated with LNG Consumption in Power Plants**




**Source:** Author's estimation and Moazzem and Fahad (2022).

emissions for the years 2022 to 2024 shows a gradual increase. From 2022 to 2024, the forecasted associated emissions are expected to rise from 204,686.8 tonnes $CO_2e$ to 281,815.7 tonnes $CO_2e$.

As too many countries including Bangladesh are considering LNG as a transition fuel – the total volume of LNG use will increase many folds, and so will be the GHG emission from LNG. An increasing focus on natural gas and coal might delay the transition to renewable energy sources, which offer more sustainable and cleaner alternatives for power generation. Delaying this transition could hinder progress toward mitigating climate change and achieving energy sustainability goals. In the long run, investments in fossil fuel-based power plants may become economically risky, as the global energy landscape is already shifting towards cleaner and more cost-effective renewable energy technologies. This could result in financial losses for investors and utilities heavily invested in fossil fuel infrastructure.

## 5.2 Other Environmental Impacts

LNG use also releases various other non-$CO_2$ air pollutants at each stage of its production, storage, transportation, and refueling. These pollutants include sulfur dioxide ($SO_2$), nitrogen dioxides ($NO_2$), particulate matter (PM), and other chemical compounds, which can have adverse effects on nearby communities. Moreover, activities like loading and unloading vessel tankers in the LNG industry generate emissions of fugitive methane, nitrous oxide (NOx), volatile organic compounds, ozone ($O_3$), and PM (Ibrahim et al., 2022).

A study in Bintulu, Malaysia, an area with natural gas industrial activity, investigated the impact of short-term exposure to air pollutants on childhood respiratory diseases. The study found a statistically significant link between exposure to PM2.5 and $SO_2$ and childhood respiratory hospitalizations (Ibrahim et al., 2022).

According to Smart Air (2020), in Bangladesh, air pollution has crossed the WHO safe limit. A significant amount of Nitrogen oxide, PM, and sulfur dioxide is emitted into the air from the power generation process (Raza et al., 2022). LNG is considered worse in terms of polluting air compared to ordinary fossil fuels since it requires carbon-intensive interventions for chilling, shipping, and regasifying LNG where the potential for leakage of dangerous methane is prevalent (NRDC, 2022). On the other part, long-term dependency on LNG requires massive infrastructure which can negatively impact the environment and society.

Land acquisition and development for LNG facilities can disrupt local ecosystems, affecting biodiversity and natural habitats. Construction activities and land conversion can lead to environmental degradation, potentially impacting water bodies, forests, and air quality in the vicinity. A study by Radonja et al. (2020) found negative environmental effects during construction, operation, and decommissioning of LNG infrastructure. It also contributes to habitat loss, marine pollution from discharges, and alterations in sea conditions. Common side effects include noise, vibration, sea turbidity, and increased traffic due to logistics and machinery. During the operation, impacts are primarily related to increased maritime traffic and potential accidents resulting from operational irregularities or technical malfunctions of wastewater. These can lead to noise, light pollution, exhaust emissions, and marine pollution, affecting ecosystems and human life quality.

## 5.3 Social Impacts

The development of LNG electric power plants often requires large scale land acquisition, which can have significant socio-economic impacts.

LNG power plant infrastructure, including regasification terminals and storage facilities, demands substantial land. Kamal (2019) estimates that every USD 1 investment on gas-depended electricity production directly uses 0.0004 hectares of land and indirectly uses 0.00016 hectare of land.[10] This may necessitate the acquisition of land, potentially affecting local communities. Land acquisition can lead to the displacement of communities residing in these areas, resulting in the loss of homes, farmland, and disruptions to traditional ways of life. For example, several reports claim that 20,000 people have lost livelihood from shrimp and salt firming due to the Matarbari coal-fired electricity plant.

BAPA and Waterkeepers Bangladesh have reported that employment and livelihood opportunities have not been provided to displaced fishermen and farmers and where compensation has been paid it has been highly variable and arbitrary. When the displaced populations do not receive adequate compensation or rehabilitation – it leads to extreme socio-economic hardships. The compensation process may lack transparency, and affected communities may feel marginalised. When appropriate skill upgrading is not provided as part of the rehabilitation – the victims end up with a lower socio-economic status with lower paid jobs.

It is difficult to quantify the full extent of the social cost, further research on this issue with field level experience may shed light on this.

[10]Kamal, Rohini, "Bangladesh's Energy Policy: Economic, Environmental, and Climate Change Impacts" (2019). Doctoral Dissertations. 1688. https://doi.org/10.7275/15197519, https://scholarworks.umass.edu/dissertations_2/1688

## 6. WAY FORWARD

### (a) Immediate expansion of RE to reduce LNG dependency

As a way forward, Bangladesh needs to change the energy mix even in the medium term to reduce LNG dependency. Greater expansion of renewable energy (RE) should be aggressively pursued. It will significantly contribute to GHG reduction, macroeconomic stability, and energy security. 'Among the other positive impacts, RE is hypothesised to reduce the vulnerability of economies against the exogenous volatility of crude oil supplies, stabilise energy prices, enhance energy-use efficiency levels, expand electricity-access rates, attribute to rural electrification, facilitate off-grid electrification and create job opportunities within the local community (Murshed & Tanha, 2021).

'In recent times, the average cost of RE production has gone down to a large extent. According to a report by the International Renewable Energy Agency, the global weighted-average costs of solar power, between 2010 and 2018, have significantly declined to almost match the corresponding costs of generating electricity from fossil fuels, oils in particular. For instance, within South Asia and the Pacific, the levelised cost of energy (LCOE) produced using solar power declined the most from being around 350 US dollars per megawatt in 2010 to 69 US dollars per megawatt by the end of 2019, while the LCOE for natural gas-fired electricity remained fairly stagnated at around 72 US dollar per megawatt (Murshed & Tanha, 2021). On the other hand, RE-based electricity generation also does not require any capacity charges and can save foreign currencies.

A clear RE-based electricity generation should be committed in the IEPMP and other policies so that the government can shift its energy plan and avert any future risks that are associated with fossil fuel-based power generation. The current policies are centered on fossil fuel-based electricity generation which are difficult for businessmen to sustain if they invest in the RE. Therefore, the government should provide more incentives to RE investors so that the RE-based electricity generation can grow.

### (b) Increased domestic natural gas exploration

There may be untapped gas reserves in Bangladesh. The government must invest in gas exploration through international partnerships and technological advancements in this domain, while simultaneously using non-renewable and renewable sources for power generation to mitigate the immediate energy security issues at hand.

'The present gas reserves in Bangladesh are limited due to inadequate planning and operations in gas exploration, and the lack of funding for the Bangladesh Petroleum Exploration and Production Company Limited (BAPEX) has further exacerbated the challenge. Unfortunately, the country has also not made any achievements in offshore gas exploration even after it had managed to secure the deep offshore regions from Myanmar and India (Bhowmick & Gosh, 2022).

### (c) Efficiency gain in production, transmission, and distribution

Bangladesh power generation, distribution and transmission processes have a lot of leakages. These leakages must be reduced to improve efficiency.

### (d) Demand side reduction

There should be substantial government, private and household investments to expand greener and more efficient energy consumption. Government codes, by-laws and incentives should play a crucial role to promote demand side efficiency.

### (e) Other policies

With a proper cost-benefit analysis, the government may consider implementing the carbon pricing for emitting $CO_2$ in the environment. It will help to curb fossil fuel-based electricity generation. Besides, the revenue generated from this sector can be invested in RE-based power generation.

The government should also phase out the fuel subsidies and stop capacity payment for fossil fuel-based electricity generation so that alternative sources can be explored properly.

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# ANNEX

## Annex 1: Implementation Progress of 5 LNG-based Power Plants with a Capacity of 3,355 MW Under Construction by the Government and Private Sector

| Name of the Plants | Contract signing date | COD | Generation capacity (MW) | Fuel type | Progress | Implemented by |
|---|---|---|---|---|---|---|
| Rupsa (2*400) 800 MW CCPP | 28-Nov-19 | Sept'24-Mar'25 | 880 | LNG | 64% | Government |
| Meghnaghat 583 MW CCPP | 14-Mar-19 | 31-Aug-23 | 583 | LNG/HSD | 90% | Private sector |
| Meghnaghat 718 MW CCPP | 1-Sep-19 | 31-Aug-23 | 718 | LNG | 95% | Private sector |
| Meghnaghat, Narayanganj 583 MW CCPP | 24-Jul-19 | 31-Aug-23 | 584 | LNG | 96% | Private sector |
| Anwara, Chittagong 509 MW CCPP | 28-Oct-21 | 1-Jan-26 | 590 | Gas/LNG | 8% | Private sector |

**Source:** BPDB (2023).

## Annex 2: Implementation Progress of 3 Power Plants of 1770 MW Capacity Under Contract Signing Process (LOI and NOA issued)

| Name of the Plants | Ownership | Installed Capacity (MW) | COD |
|---|---|---|---|
| Meghna Ghat 450 MW CCPP | IPP | 450 | Jan-26 |
| Ghazaria 660 MW CCPP | IPP | 660 | Jan-26 |
| Mirsrai 660 MW CCPP | IPP | 660 | Jun-27 |

**Source:** BPDB (2023).

## Annex 3: LNG Plants to be Established in the Near Future

| Name of Power Plants | Ownership | Installed Capacity | Fuel Type | COD | Current Status |
|---|---|---|---|---|---|
| Haripur 250 MW power plant | BPDB | 250 | LNG | 2026 | Feasibility study completed |
| Payra 1200 MW CCPP (1st phase) | NWBP GCL | 1200 | LNG | 2027 | Feasibility study of power plant section completed |
| Ghorashal 225 MW power plant | BPDB | 225 | LNG | 2027 | Feasibility study completed |
| Mymensingh 400+-10% MW CCPP | BR power zone | 400 | LNG | 2027 | Feasibility study completed |
| Bheramara Veramara 150 MW power plant | BPDB | 150 | LNG | 2030 | Primary phase ongoing |
| Siddhirganj 450 MW CCPP | BPDB | 450 | LNG | 2032 | Feasibility study completed |

*(Annex 3 contd.)*

*(Annex 3 contd.)*

| Name of Power Plants | Ownership | Installed Capacity | Fuel Type | COD | Current Status |
|---|---|---|---|---|---|
| Sonagazi, Feni 600+-10% MW CCPP | EGCB | 550 | LNG | 2033 | Feasibility study completed |
| Gozaria 600+-10% MW CCPP | RPCL | 550 | LNG | 2034 | Feasibility study completed |
| 500-600 MW LNG based CCPP (JV of CPGCBL & Mitsui & Co. Ltd. Japan) | JV (Japan) | 587 | LNG | Jun-28 | Consultant firm recruitment is ongoing for conducting feasibility study and ESIA study |
| Moheshkhali 3*1200 MW LNG based CCPP (1st phase) | JV | 1200 | LNG | Jun-30 | MoU signed between GE & BPDB |

**Source:** BPDB (2023).

### Annex 4: RLNG Send Out (Million Standard Cubic Feet (MMSCF))

| Period | Monthly | Yearly |
|---|---|---|
| Jul-21 | 21361.60 | 235906 |
| Aug-21 | 21193.50 | |
| Sep-21 | 19321.70 | |
| Oct-21 | 22757.60 | |
| Nov-21 | 18159.90 | |
| Dec-21 | 16295.90 | |
| Jan-22 | 13258.20 | 201916 |
| Feb-22 | 14712.50 | |
| Mar-22 | 20361.30 | |
| Apr-22 | 21063.40 | |
| May-22 | 22477.10 | |
| Jun-22 | 21674.10 | |
| Jul-22 | 14958.10 | |
| Aug-22 | 16932.60 | |
| Sep-22 | 13941.90 | |
| Oct-22 | 11428.40 | |
| Nov-22 | 11038.30 | |
| Dec-22 | 14083.90 | |
| Jan-23 | 13180.80 | 171317 |
| Feb-23 | 12193.60 | |
| Mar-23 | 21894.30 | |
| Apr-23 | 21334.00 | |
| May-23 | 20677.90 | |
| Jun-23 | 24840.00 | |
| Jul-23 | 23064.90 | |

*(Annex 4 contd.)*

*(Annex 4 contd.)*

| Period | Monthly | Yearly |
|---|---|---|
| Aug-23 | 22377.60 | |
| Sep-23 | 6037.93 | |

**Source:** RPGCL, (n.d.).

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