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Working Paper 144

Economic and Environmental Cost Estimation of LNG Import

Revisiting the Existing Strategy of Imported LNG

Khondaker Golam Moazzem
Abdullah Fahad
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CENTRE FOR POLICY DIALOGUE

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The present paper titled ***Economic and Environmental Cost Estimation of LNG Import: Revisiting the Existing Strategy of Imported LNG*** has been authored by *Dr Khondaker Golam Moazzem*, Research Director, CPD (moazzem@cpd.org.bd), *Abdullah Fahad*, Senior Research Associate, CPD (fahad@cpd.org.bd) and *Dr Shah Md. Ahsan Habib*, Professor (Selection Grade), Bangladesh Institute of Bank Management (BIBM) (ahsan@bibm.org.bd).

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

Abstract

While Bangladesh's energy scenario has been historically dominated by natural gas assuming that Bangladesh will never face a shortage in natural gas production, the local natural gas production started decreasing after 2016 and is likely to decrease even more in the coming years. Increasing demand for gas and decreasing local production led Bangladesh to import Liquefied Natural Gas (LNG) in 2018. Power plants account for the major share of the gas consumed in Bangladesh. This study estimates the economic costs of the LNG supply chain considering the power plant as an end customer in Bangladesh for the fiscal years 2019 to 2021. A supply chain was identified to estimate the economic costs of LNG in Bangladesh based on the data collected from relevant government agencies. It was found that per unit LNG import cost, was about 24 times that of the national company production. Environmental emissions associated with the imported LNG were also estimated in the study based on literature. LNG life cycle emissions indicate that LNG is not that of improvement from other fossil fuels. The study concludes that to meet the existing gas demand of Bangladesh currently there are no alternatives to LNG import, but, considering LNG as a long-term solution going to cost the country gravely.

Keywords: Liquefied Natural Gas (LNG), economic costs, import, environmental emissions, gas scenario, life cycle emissions, supply chain

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The study is authored by *Dr Khondaker Golam Moazzem*, Research Director, CPD, *Mr Abdullah Fahad*, Senior Research Associate, CPD, and *Dr Shah Md. Ahsan Habib*, Professor (Selection Grade), Bangladesh Institute of Bank Management (BIBM).

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Acronyms

AIT	Advance Income Tax
BCF	Billion Cubic Feet
BDT	Bangladeshi Taka
BERC	Bangladesh Energy Regulatory Commission
BOOT	Build Own Operate and Transfer
BPDB	Bangladesh Power Development Board
CCPP	Combined Cycle Power Plant
CIF	Cost, Insurance, and Freight
CPD	Centre for Policy Dialogue
CM	Cubic Meter
CNG	Compressed Natural Gas
EEBL	Excelerate Energy Bangladesh Limited
FSRU	Floating Storage Regasification Unit
FY	Fiscal Year
GHG	Greenhouse Gas
GIIGNL	International Group of Liquefied Natural Gas Importers
GoB	Government of Bangladesh
GSA	Gas Supply Agreement
GSMP	Gas Sector Master Plan
GTCL	Gas Transmission Company Limited
GW	Gigawatt
IFC	International Finance Corporation
IGU	International Gas Union
IOCL	Indian Oil Corporation Limited
IPP	Independent Power Producer
JKM	Japan Korea Marker
KGDCL	Karnaphuli Gas Distribution Company Limited
LCA	Life Cycle Assessment
LNG	Liquefied Natural Gas
MMBTU	Million British Thermal Unit
MMSCFD	Million Cubic Feet per Day
MoPEMR	Ministry of Power, Energy and Mineral Resources
MW	Megawatt
NG	Natural Gas
NRDC	Natural Resources Defense Council
NWPGCL	North-West Power Generation Company Limited

OTI	Oman Trading International
OQT	OQ Trading Limited
PSMP	Power Sector Master Plan
RPGCL	Rupantarita Prakritik Gas Company Limited
TDS	Tax Deducted at Source
TUA	Terminal Use Agreement
UNECE	United Nations Economic Commission for Europe
USA	United States of America
USD	United States Dollar
VAT	Value Added Tax

1. INTRODUCTION

1.1 Background and Objective

Bangladesh's energy scenario has been historically dominated by natural gas and accordingly, the current energy supply infrastructure of Bangladesh hugely depends on natural gas. At the beginning of the last decade, Bangladesh started realizing that the natural gas reserves in Bangladesh would not last long, and by the end of the last decade, the country's local gas production started declining. Since the infrastructure is mainly based on gas, Bangladesh had no other (immediate) solution, but to turn to Liquefied Natural Gas (LNG) to meet the existing demand.

Gas was the major (46%) primary energy supply source in Bangladesh in FY2020–21 (MoPEMR, 2021). The situation is even more dominant in the power sector. The share of gas-based power plants (installed capacity) was 52% in the same fiscal year (BPDB, 2021). The country's local gas production was 892 Billion Cubic Feet (Bcf) in FY2020–21, which decreased by 8% from FY2016–17 (MoPEMR, 2021). The country decided to go for LNG in its Gas Sector Master Plan 2017 (GSMP 2017). Increasing demand for gas and decreasing local production led Bangladesh to import LNG from 2018, and the demand is expected to go up further. According to GSMP 2017, the daily demand for gas will reach 5005 MMscf in 2030.

Imported LNG is added to the national grid after regasification. Bangladesh now has two operational Floating Storage Regasification Units (FSRUs) in Maheshkhali, Cox's Bazar with a capacity of 1000 million cubic feet per day (MMscfd). Considering the higher operating cost of FSRU, Bangladesh is also considering the establishment of a land-based LNG terminal with a capacity of 1,000 MMscfd in Matarbari, Cox's Bazar.

The sharp increase in the spot LNG price last year led Bangladesh to buy LNG at 35.89 USD/MMBtu and 36.95 USD/MMBtu for October 2021 delivery (Rahman, 2022). Now, the recent media speculation of the potential rise of gas prices at the consumer level points to the costs and expenses associated with the supply price of natural gas, specifically the import price of LNG which seems to affect the price of gas supply significantly. The contemporary development of the rise in the spot price of LNG and the Ukraine crisis is adding to the concern.

In this evolving situation, a crucial question is how expensive is the decision of shifting to LNG for Bangladesh? What is the economic cost of importing LNG into the country? What about the implications of the growing imports of LNG to the environment?Would the exiting strategy create a cost burden and over-dependence on external sources of LNG? Is it the best option considering the economic and environmental costs associated with LNG import?

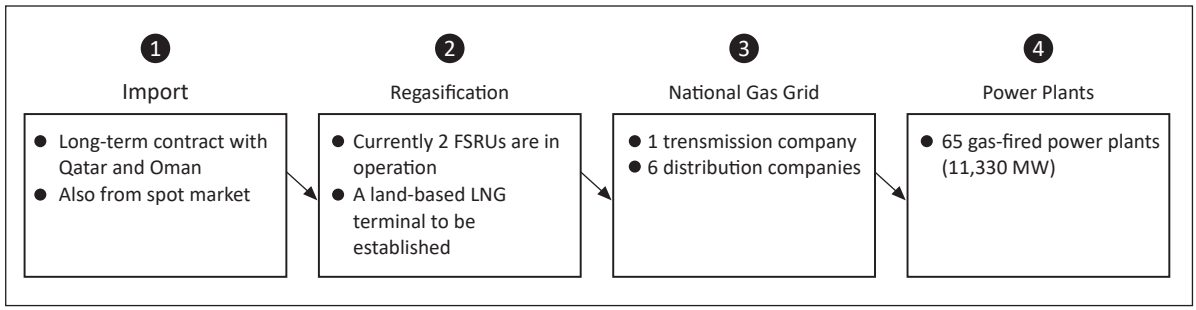
The study is an attempt to estimate the economic cost of LNG import and the associated environmental cost in the context of Bangladesh, and revisit the existing strategy of extensive dependence on imported LNG to meet the projected demand of the power sector.

1.2 Identification and Application of Methodology for the Study

1.2.1 Defining LNG Supply Chain for Bangladesh

Four distinctive stages can be identified in the LNG supply chain (Figure-1) for Bangladesh starting from import and ending at end consumers e.g. power plants (for this study). Imported LNG goes

Figure 1: LNG Supply Chain for Bangladesh



Source: Authors' Illustration.

through regasification and re-gasified LNG is then transferred into the national gas grid. Power plants receive natural gas from national grids through distribution companies.

Bangladesh imports LNG under long-term contracts and procures from the spot market as well. The country currently has two long-term contracts with Qatar and Oman; and also has signed agreements with 16 companies to import LNG from the spot market.

The country currently has two operational LNG terminals, both are Floating Storage Regasification Units (FSRUs). These two FSRUs have a capacity of 500 million standard cubic feet per day (MMscfd) each and are located near Moheshkhali Island in cox's Bazar.

A pipeline has been constructed to connect the FSRUs to the national gas grid, and re-gasified LNG is transported to the national gas grid through this. The Gas Transmission Company Limited (GTCL) – a subsidiary of the Bangladesh Oil, Gas & Mineral Corporation, also known as Petrobangla owned by the Government of Bangladesh (GoB) – is the sole company responsible for gas transmission in Bangladesh. All six gas distribution companies are subsidiaries of Petrobangla. Power plants are the major clients of these gas distribution companies in Bangladesh.[1] Rupantarita Prakritik Gas Company Limited (RPGCL), another subsidiary of Petrobangla has been assigned the task of conducting LNG-related operations in the country.

1.2.2 Estimation of Economic Costs

The economic costs estimation has been broken down into 4 steps.

Step 1: Per unit import cost has been calculated based on the costs incurred to import LNG in Bangladesh. VAT, Advance Income Tax (AIT), financing costs, and bank costs have been added on top of the purchase price of LNG.

Step 2: LNG regasification cost per unit at the regasification stage has been calculated based on the LNG regasification charge in each FSRUs. Being private commercial entities, their charge is expected to include their entire economic costs. There is also an additional cost component that is also been added.

[1]In FY 2020–21 about 58% of the total gas was sold to the power plants including captive power plants (MoPEMR, 2021). According to BPDB, in the beginning of March 2022, there were 65 gas-based power plants with an installed capacity of 11,330 MW.

Step 3: There are some cost components after the regasification like the operational costs of RPGCL, Tax Deducted at Source (TDS), and the operational cost of Petrobangla. All of this has been added in this step.

Step 4: The transmission and distribution cost of LNG has been added in the last step of the economic cost estimation.

1.2.3 Per Unit Economic Cost

Per unit economic cost of re-gasified natural gas has been estimated by summing up all the cost components at the different stages and up to the entry point of the Power Plants.

$$Per\ Unit\ Economic\ Cost$$
$$= [\{(Total\ Import\ Costs + Total\ Regasification\ Costs + Total\ RPGCL\ Operational\ Costs)/(0.93 * Regasified\ LNG\ Volume)\}$$
$$+ Petrobangla\ Operational\ Cost\ per\ unit + Transmission\ Cost\ per\ unit + Distribution\ Cost\ per\ unit]$$

1.2.4 Associated Environmental Emissions

In a comparative Life Cycle Assessment (LCA) of LNG, four impact categories have been considered: (a) climate change, (b) photochemical smog, (c) particulate matter, and (d) acidification (MacConnell & Grant, 2020). In LNG operations, Carbon Dioxide (CO2), Methane (CH4), and Nitrous Oxide (N2O) are the primary Greenhouse Gas (GHG) emissions (The Levon Group, LLC, 2015). For this study, only the climate change impact of the LNG supply chain is considered. The emission calculation has been conducted based on standard emission data available in the literature.

2. GLOBAL LNG TRADE, PRICE, AND USE FOR POWER GENERATION

2.1 Global LNG Trade

In 2020, 801,240 cubic meters (356.1 million tonnes) of LNG were imported, with a 0.4% growth from 2019 of which 40% of the total trade was spot or short-term basis. The LNG trading market consists of 20 exporting countries and 43 importing economies. The global export and import scenario can be understood from Tables 1 and 2. About 71% of the total global import was for Asia whereas 41% of the LNG volumes were supplied from the Pacific Basin (GIIGNL, 2021). Australia was the largest exporter followed by Qatar and USA where Japan was the largest importer followed by China. Bangladesh came in fourteenth in the import ranking in 2020 because of its rising volume of imports of LNG.

Table 1: LNG Import in 2020

LNG Import in 2020			
SN	**Country**	**Volume (Million Cubic Meter)**	**Market Share**
1	Japan	164,820	21%
2	China	155,990	19%
3	South Korea	91,810	12%
4	India	59,310	8%
5	Taiwan	39,610	5%
6	Spain	34,990	4%

(Table 1 contd.)

(Table 1 contd.)

LNG Import in 2020			
SN	**Country**	**Volume (Million Cubic Meter)**	**Market Share**
7	United Kingdom	30,690	4%
8	France	29,370	4%
9	Turkey	24,130	5%
10	Italy	20,490	3%
11	Pakistan	16,670	2%
12	Thailand	12,650	2%
13	Netherlands	12,140	2%
14	Bangladesh	9,380	1%
15	Portugal	9,140	1%
16	Kuwait	9,130	1%

Source: International Group of LNG Importers.

Table 2: LNG Export in 2020

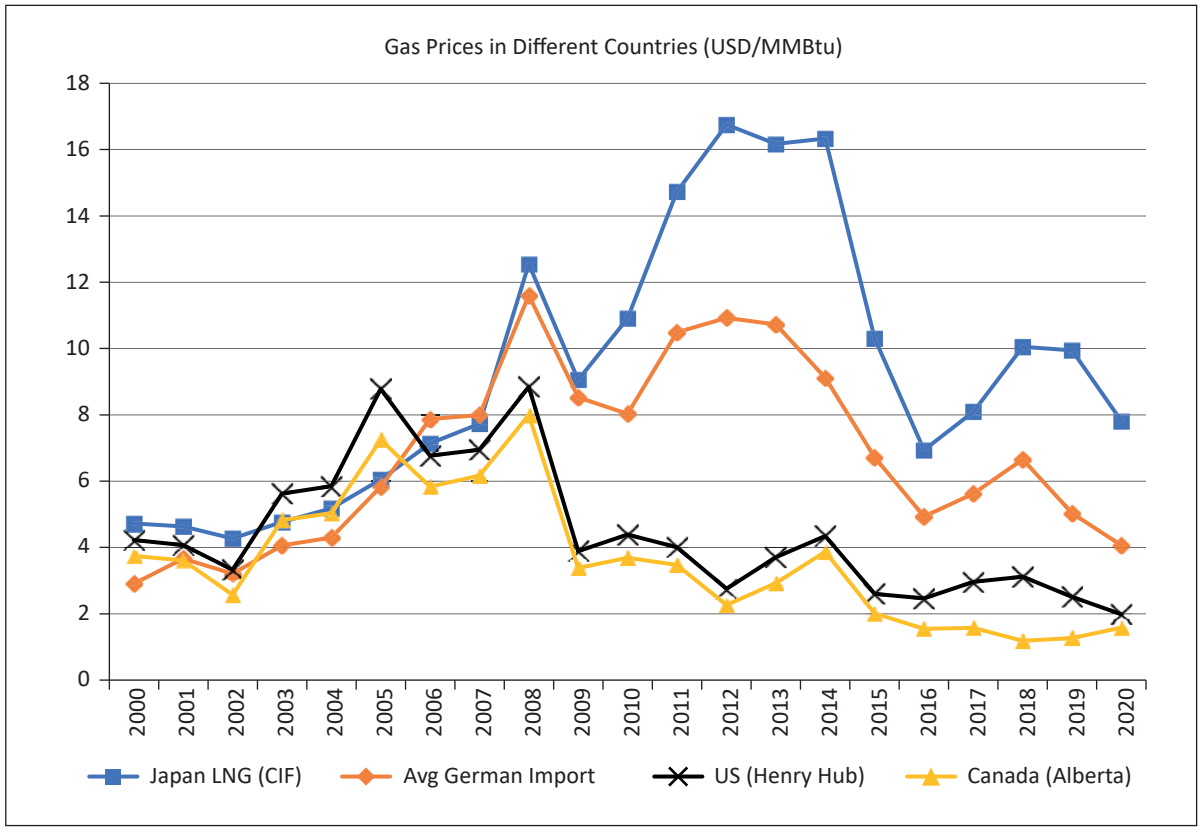
LNG Export in 2020			
SN	**Country**	**Volume (Million Cubic Meter)**	**Market Share**
1	Australia	175,460	22%
2	Qatar	173,220	22%
3	United States	103,410	13%
4	Russia	66,770	8%
5	Malaysia	52,700	7%
6	Nigeria	45,510	6%
7	Indonesia	33,960	4%
8	Algeria	23,500	3%
9	Trinidad and Tobago	23,640	3%
10	Oman	21,260	3%

Source: International Group of LNG Importers.

2.2 Global LNG Price

It was usually said that the LNG price is relatively competitive compared to other energy in the case of distant markets (Furlonge, 2008). However, given its close association with the supply of natural gas, volatility in the natural gas market has directly impacted the volatility of the LNG market. It is found that the cost of LNG in the Atlantic basin region was in the range of USD 3.4-5.95 per MMBtu while the major share in this cost range is from exploration and production which is between 0.75 and 2.0 USD per MMBtu, but the cost of regasification was only about USD 0.4-0.7 per MMBtu. The study found that the annual growth rate for LNG (7% in 2000-08) was way higher than the world energy demand (1.6%) and with high demand and relatively tight supply, the gas prices increased – average US Henry Hub gas prices jumped to USD 5.00 in 2006 from USD 2.00 in 1999 per MMBtu (Furlonge, 2008). The LNG supply sources (e.g. Trinidad and Tobago, Qatar) started to develop in the early to mid-2000s as the cost to supply started to be compatible with the predominant pipeline gas prices and since 2010, the regional gas prices started to diverge – US prices below 4.5 USD/

Figure 2: Gas Prices in Different Countries



Source: bp Statistical Review of World Energy 2021.

MMBtu, European hub price 8-11 USD/MMBtu, Asian LNG 15 USD/MMBtu which is contractually linked to oil prices (Songhurst, 2014).

In the early 2000s, the gas prices in different countries were not that different.[2] Between 2000- and 2008, prices in North American (US and Canada) region were a little higher than in Germany. Since 2008, the LNG price in Japan has been at the top which continued till date (2000). The price range for these countries was about the same till 2007. From 2008, the dispersion of the gas price started to expand and it was the highest in 2012 (Figure 2). Japan's LNG price was USD 14.48 higher than the Canadian gas price. The gas prices in Europe were also significantly higher than the North American prices. These price gaps created business opportunities in Europe and Asia for gas exporters in North America. After 2012, the prices in these regions have started to converge. The range of dispersion became less than half in 2020 from the 2012 level when it was highest in the last two decades.

According to International Gas Union's (IGU) 2021 World LNG Report, "The global LNG market experienced an eventful 2020, during which spot prices of cargoes trading in the Atlantic and the Asia Pacific basins plummeted to record lows in the first six months, and then waged a breath-taking rally to hit multiyear highs at the start of 2021" (Rystad Energy, 2021). As discussed, the LNG price has increased further after the Ukraine war where Russia as a major exporter of gas has

[2]US gas price refers to the gas price in Henry Hub in Louisiana and Canadian price refers to the price in Alberta. German price is the average import price whereas Japan LNG price is the Cost, Insurance, and Freight (CIF) price.

got involved. Because of sanctions imposed on LNG imports from Russia by the USA, UK and other countries, the LNG market has become volatile.

2.3 Global LNG Use in Power Generation

Japan is the largest LNG importer in the world since it has a very limited natural gas production capacity (about 3% of the total energy supply in 2020). In 2020, the country generated 38% of the total electrical energy using natural gas as a fuel supply. India, the largest LNG importer in South Asia met about 61% of its natural gas demand through imports in 2020. However, the power sector of India doesn't rely on natural gas as it only generated about 4% of the total electrical energy using natural gas in 2020. United Kingdom's energy supply is predominantly based on natural gas. About 50% of the country's energy supply was met by (net) natural gas import. Natural gas is also a dominant fuel – 38% of the total fuel supply in 2020 – in power generation for the United Kingdom.

3. BANGLADESH'S LNG INFRASTRUCTURE, IMPORT, AND USE FOR POWER GENERATION

3.1 LNG Infrastructure

Realizing the mismatch between local production and the increasing demand for natural gas in Bangladesh, the government initiated a project to import LNG from Qatar back in 2010 (King & Spalding, 2017). In line with that, a few years later, the government took the initiative to install a Floating Storage Regasification Unit (FSRU) with a capacity of 500 MMscfd in Maheshkhali and construct a 30" diameter 115 km transmission pipeline from Moheshkhali to Fouzdarhat to transfer the re-gasified LNG to the national grid (Petrobangla, 2015). A Terminal Use Agreement (TUA) was signed in July 2016 for 15 years on a BOOT (Build Own Operate and Transfer) basis with Excelerate Energy Bangladesh Limited (EEBL) to establish a Floating Storage Regasification Unit (FSRU). Another TUA was signed for a second FSRU with Summit LNG Terminal Co. (Pvt.) Ltd. on 2 April 2017 also for 15 years (2019 – 2033) on a BOOT basis. The project cost for "Excellence" was estimated at USD 179.4 million, with the project company (EEBL) planning to fund 70% of the project with the loan and 30% with equity (IFC, 2022).

Bangladesh has two LNG terminals in operation now, both are Floating Storage Regasification units (FSRUs). The first one named "Excellence" commercially started its operation in August 2018. The contract is for 15 years (2018 – 2032) on a BOOT (Build Own Operate and Transfer) basis. The second contract was signed with Summit LNG Terminal Co. (Pvt.) Ltd. in April 2017, also for 15 years (2019 – 2033) and BOOT basis. This second LNG terminal ("Summit LNG") started its commercial operation in April 2019. Both of these terminals have a regasification capacity of 5000 MMscfd and a storage capacity of 138,000 CM and are also located near Moheshkhali Island, Cox's Bazar (RPGCL, 2022).

A land-based LNG terminal with a regasification capacity of 1000 MMscfd is going to be established in Matarbari Cox's Bazar on a BOOT basis. RPGCL appointed a consulting firm in December 2020 for the techno-economic feasibility study, engineering service, and tender management service. The firm already has completed the feasibility study (RPGCL, 2021).

A 30-inch 91-km pipeline from Maheshkhali to Anowara was completed in June 2018 to transfer re-gasified LNG to the National gas supply (GTCL, 2022). To supply the re-gasified LNG to the

distribution areas of KGDCL, a 42-inch 30-km gas transmission pipeline from Anowara to Fouzdarhat was completed in March 2020 (GTCL, 2022). A parallel pipeline from Maheshkhali to Anowara was also completed in June 2021 (GTCL, 2022).

Bangladesh is also considering importing LNG through a cross-border pipeline. An MoU was signed between Petrobangla and Indian Oil Corporation Limited (IOCL) in 2017. A Gas Supply Agreement (GSA) is under process with IOCL now. Petrobangla signed another MoU with H-Energy in June 2021 for importing LNG through the cross-border pipeline (RPGCL, 2021).

In March 2018, Summit and Mitsubishi Corporation have signed a memorandum of understanding for a USD 3 billion integrated LNG terminal and power project in Bangladesh (Summit, 2022). Overall, a rise in LNG use in the coming years would require a considerable amount of investment by the private sector. Such investment based on debt finance would further squeeze the availability of debt finance for investment in renewable energy. Such investments along with the price of imported LNG are likely to cause higher unit prices compared to that of other fossil-fuel-based energy.

3.2 LNG Import

LNG imports in Bangladesh increased from 2018 to 2021 (table 3).Bangladesh signed a long-term contract with Qatargas on 25th September 2017 for 15 years (2018-2032). Under this contract, 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) – formally 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 till June 2021.

Apart from long term contracts, Bangladesh is having contracts with 16 companies to import LNG from the spot market. Bangladesh imported its first LNG from the spot market on 25th September 2020. Till 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. In the fiscal year 2018–19, the import was 5,727,618 cubic meters and it became almost double in the fiscal year 2020–21.

Table 3: LNG Import

Fiscal Year	Long-term Contract		Spot Market		Combined		Ratio (long-term: Spot Market)
	Volume (CM)	Growth Rate	Volume (CM)	Growth Rate	Volume (CM)	Growth Rate	
2018–19	5,727,618	-	-	-	5,727,618	-	-
2019–20	9,456,779	65%	-	-	9,456,779	65%	-
2020–21	8,564,692	-09%	1,585,934	-	10,150,626	7%	84:16
Total	23,749,089		1,585,934		25,335,023		94:06

Source: Rupantarita Prakritik Gas Company Limited.

In the first two fiscal years, Bangladesh only imported through long-term contracts. Bangladesh started importing from the spot market in the third year and the spot market share of the imported LNG was about 16 per cent in that year.

3.3 LNG/NG use in Power Generation

Historically, Bangladesh's energy sector is largely developed based on domestic gas reserve; gas has been the dominant fuel supply in Bangladesh's power generation mix. In 2010, 83% (BPDB, 2010) of the power generation capacity relied on gas while in 2021, it has reduced to 52% (BPDB, 2021). In other words, the importance of domestic gas in power generation has been decelerated with the depleting domestic gas reserve. Bangladesh has a 29.93 Tcf recoverable gas reserve among which 18.68 Tcf was already produced as of June 2021 (MoPEMR, 2021). Gas has been the focal point of the energy mix in policy planning in early power sector master plans (PSMP 2005). However, the subsequent master plans (PSMP 2010, PSMP 2016) focused on coal considering the depleting gas reserve. However, the actual use of coal was not that level as was planned rather gas remained the main source of energy in power generation during the subsequent planned period. Because of the global commitment against coal in recent years as well as the lack of available finance for coal-based power plants Bangladesh is heading towards a gas-based energy mix again.

At present, 11% of total gas used in power generation came from imported LNG.[3] On the other hand, there are now 11 power plants (Table 4) in the pipeline that will be relying on imported LNG as a fuel supply. The combined capacity of those power plants is about 6.5 GW and all are Combined Cycle Power Plants (CCPP). These power plants are being set up either under IPP or BPDB. The largest two LNG based power plants will be set up by NWPGCL.

Table 4: Proposed LNG-based Power Plants

SL.	Name of the Power Plant	Capacity (MW)	Ownership	Expected Commissioning Date
1	Meghnaghat 600 MW CCPP	584	IPP	August 2022
2	Meghnaghat 600 MW CCPP (Unit-2)	583	IPP	August 2022
3	Meghnagat 750 MW CCPP	718	IPP	February 2023
4	Rupsa 800 MW CCPP	880	NWPGCL	June 2023, December 2023
5	Haripur 250 MW CCPP	250	BPDB	December 2023
6	Raojan 400±10% MW CCPP (1st Unit)	438	BPDB	June 2024
7	Payra 1200 MW LNG based CCPP (1st Phase)	1,200	NWPGCL	June 2024
8	Anowara 590 MW CCPP	590	IPP	June 2024
9	Meghnaghat 500 MW CCPP	450	IPP	June 2024
10	Ghorasal 225 MW CCPP	225	BPDB	June 2025
11	Shiddirgonj 600±10% MW CCPP	550	BPDB	June 2025
	Total Capacity (MW)	**6,468**		

Source: Bangladesh Power Development Board (BPDB).

[3]Bangladesh met its 19 percent of natural gas demand through LNG import last fiscal year (2020–21). 1017 Bcf gas was consumed in Bangladesh on that year, among which 426 Bcf gas was consumed in Power Plants (595 Bcf considering captive power). Thus, it can be estimated that 8 percent (11 percent considering captive power) of the gas consumed in the power plants came from imported LNG in the fiscal year 2020–21.

4. ESTIMATION OF ECONOMIC COSTS OF RE-GASIFIED LNG IN BANGLADESH FOR POWER GENERATION

As narrated in the methodology section (1.2), the costs of Re-gasified LNG are estimated considering its costs broken down into four steps.

Step 1: Per unit import cost has been calculated based on the costs incurred to import LNG in Bangladesh. VAT, AIT, financing costs, and bank costs have been added on top of the purchase price of LNG.

Step 2: LNG regasification cost per unit at the regasification stage has been calculated based on the LNG regasification charge in each FSRUs. Being private commercial entities, their charge is expected to include their entire economic costs. There is also an additional cost component that is also been added.

Step 3: There are some cost components after the regasification like the operational costs of RPGCL, Tax Deducted at Source (TDS), and the operational cost of Petrobangla. All of this has been added in this step.

Step 4: The transmission and distribution cost of LNG has been added in the last step of the economic cost estimation.

4.1 Import Costs

The annual total purchase prices for LNG were collected for each of the long-term contracts. Per unit import price for them was then calculated. Bangladesh paid 8.97 USD/MMBtu for imported LNG from Qatargas in 2018–19. The unit price decreased in the following years and it was 6.23 USD/MMBtu in 2020–21 (Table 5).

Table 5: Import Prices from Qatargas

Fiscal Year	2018–19	2019–20	2020–21
Total Imported Amount (MMBtu)	106,079,742	119,767,269	129,612,917
Total Purchase Price (USD)	951,087,409	921,865,153	806,941,598
Unit Price (USD/MMBtu)	8.97	7.70	6.23

Source: Rupantarita Prakritik Gas Company Limited.

The same happened with OQ Trading Limited, the import price for the first year was higher than in the following years. In 2018–19, Bangladesh paid 8.08 USD/MMBtu and paid 6.29 USD/MMbtu in 2020–21 (Table 6).

Table 6: Import Prices from OQ Trading Limited

Fiscal Year	2018–19	2019–20	2020–21
Total Imported Amount (MMBtu)	26,577,618	99,261,191	68,753,915
Total Purchase Price (USD)	214,722,187	697,250,081	432,679,237
Unit Price (USD/MMBtu)	8.08	7.02	6.29

Source: Rupantarita Prakritik Gas Company Limited.

Bangladesh's initial interest in the spot market was to purchase LNG at a cheaper price, but Bangladesh ends up purchasing at a rate higher than existing long-term contracts. Bangladesh paid 7.98 USD/MMBtu on average for the purchases from the spot market in 2020–21 (Table 7).

Table 7: Import Prices from Spot Market

Fiscal Year	**2020–21**
Total Imported Amount (MMBtu)	36,731,817
Total Purchase Price (USD)	293,001,458
Unit Price (USD/MMBtu)	7.98

Source: Rupantarita Prakritik Gas Company Limited.

A comparison of prices over the years from these three different sources can be visualized in the table 8 below.

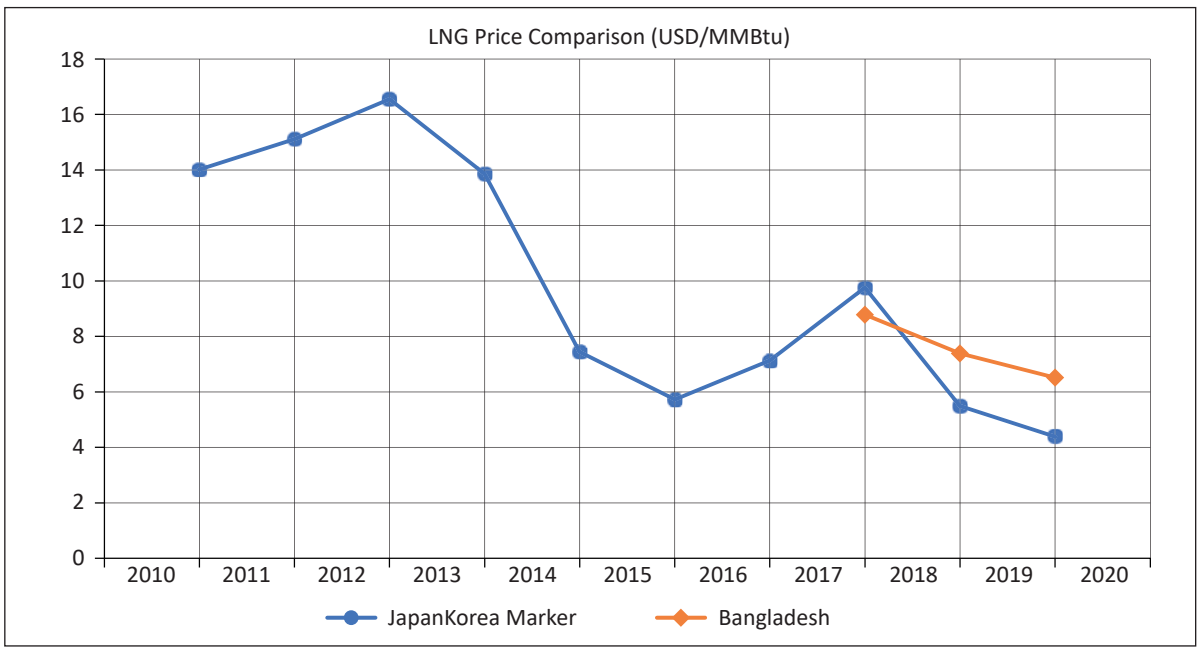
Table 8: Comparison of Import Prices from different sources (Taka/CM)

Fiscal Year	**2018–19**	**2019–20**	**2020–21**
Qatargas (USD/MMBtu)	8.97	7.70	6.23
OQ Trading Limited (USD/MMBtu)	8.08	7.02	6.29
Spot Market (USD/MMBtu)	-	-	7.98

Source: Rupantarita Prakritik Gas Company Limited.

Bangladesh's average LNG import price in 2018-19 was 8.79 USD/MMBtu and is reduced to 6.52 USD/MMBtu in 2020–21. Japan Korea Marker (JKM) price refers to the spot market value of cargoes delivered ex-ship into Northeast Asian countries. JKM price was higher than Bangladesh's average import in 2018 but, in 2020 JKM price became less than the average Bangladesh import price (Figure 3).

Figure 3: Comparison of LNG Import Price of Bangladesh with JKM Price



Source: Rupantarita Prakritik Gas Company Limited & bp Statistical Review of World Energy 2021.

LNG import costs have been calculated by adding all the associated costs (VAT, AIT, financing costs, bank charges) in the import stage with the LNG purchase prices in a given year and then dividing it by the total import quantity in gas volume. LNG is consumed as natural gas in the power plants in Bangladesh after regasification. To have a unified unit in all parts of the calculation, imported quantity in gas volume was considered which is the re-gasified LNG volume.

$$Per\ Unit\ Import\ Cost = \frac{(Total\ Purchase\ Price + VAT + AIT + Financing\ Costs + Bank\ Charges)}{Re - gasified\ LNG\ Volume}$$

Based on the calculation annual import costs were as follows (Table 9) for Bangladesh for the last three years.

Table 9: Annual Average Import Costs

Fiscal Year	2018-19	2019–20	2020–21
Re-gasified LNG Volume (Cubic Meter)	3,281,525,443	5,744,875,153	6,119,240,305
Total Import Costs (Taka)	121,489,018,074	168,727,998,562	159,714,569,100
Per Unit Import Cost (Taka/CM)	37.02	29.37	26.10

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited and Petrobangla

4.2 Regasification

The regasification is done by two companies in Bangladesh. The government pays these companies for regasification on daily basis as per the BOOT contract. Regasification charge paid to these two companies has been collected for each year. There is also an additional cost component at the port (at cost charge), that has also been collected. Then per unit regasification cost has been calculated (Table 10) based on the formula below:

$$Per\ Unit\ Regasification\ Cost = \frac{(Total\ Regasification\ Charge + At\ Cost\ Charge)}{Re - gasified\ LNG\ Volume}$$

Table 10: Regasification Costs

Fiscal Year	2018-19	2019–20	2020–21
Re-gasified LNG Volume (CM)	3,281,525,443	5,744,875,153	6,119,240,305
Re-gasification Charge (Taka)	7,603,347,750	14,796,060,975	14,857,269,445
At Cost Charge (Taka)	307,671,743	369,043,900	431,026,664
Total Regasification Costs (Taka)	7,911,019,493	15,165,104,875	15,288,296,109
Per Unit regasification Cost (Taka/CM)	2.41	2.64	2.50

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited.

There are some cost components after regasification. All activities related to LNG have been entrusted to RPGCL by the Government of Bangladesh (GoB). There is a cost component for RPGCL operational activities. This cost has been taken into consideration in this step. There is a tax (TDS) on top of the total LNG charge which has also been taken into consideration here. The per-unit cost

of re-gasified LNG before it gets transferred into the national grid has been estimated considering all of these cost components.

4.3 Transmission & Distribution (National Grid)

Gas Transmission Company Limited (GTCL) charges per cubic meter of gas transferred by them at a rate fixed by the Bangladesh Energy Regulatory Commission (BERC). The rate is now 0.4235 taka per cubic meter and was also the same for the calculated fiscal years.

Gas distribution companies also charge a fee per cubic meter of gas distributed by them at a rate fixed by BERC. It is 0.25 taka per cubic meter for all distribution companies except for PGCL which is 0.2603 taka per cubic meter. The rate was also even throughout the calculated years. In this report, 0.25 taka per cubic meter has been considered for all calculations.

4.4 Per Unit Economic Cost and Cost Breakdown

There is a management cost for Petrobangla as well and it is 0.055 taka per cubic meter of gas. This has also been considered in the estimation of per-unit economic costs. The formula identified in the methodology is then used to calculate the per-unit economic cost of LNG in Bangladesh.

$$Per\ Unit\ Economic\ Cost$$
$$= [\{(Total\ Import\ Costs + Total\ Regasification\ Costs + Total\ RPGCL\ Operational\ Costs)/(0.93 * Regasified\ LNG\ Volume)\}$$
$$+ Petrobangla\ Operational\ Cost\ per\ unit + Transmission\ Cost\ per\ unit + Distribution\ Cost\ per\ unit]$$

Per unit economic cost for LNG in the year 2018-19 was about 43.3445 taka, and it was reduced to 31.5336 taka in the year 2020–21. The detailed economic cost estimation is given in the table 11 below:

Table 11: Detailed Economic Costs Estimation

Fiscal Year	2018-19	2019–20	2020–21
Re-gasified LNG Volume (CM)	3,281,525,442.92	5,744,875,152.57	6,119,240,305.43
Total Import Price (Taka)	99,093,815,720.81	137,624,794,911.94	130,272,894,861.56
Per unit Import Price of LNG (Taka/CM)	30.20	23.96	21.29
VAT (15% on LNG Purchase Price)	14,864,072,358.12	20,643,719,236.79	19,540,934,229.23
AIT (2% on LNG Purchase Price)	1,981,876,314.42	2,752,495,898.24	2,605,457,897.23
Financing Costs (4%)	3,963,752,628.83	5,504,991,796.48	5,210,915,794.46
Bank Charge & Commission (1.6%)	1,585,501,051.53	2,201,996,718.59	2,084,366,317.78
Total Import Costs (Taka)	121,489,018,073.71	168,727,998,562.04	159,714,569,100.27
Per unit Import Costs (Taka/CM)	37.02	29.37	26.10
Regasification Charge (Taka)	7,603,347,750.00	14,796,060,975.15	14,857,269,445.40
At Cost Charge (Taka)	307,671,743.23	369,043,899.71	431,026,663.95
Total Regasification Costs (Taka)	7,911,019,493.23	15,165,104,874.86	15,288,296,109.35
Per unit Regasification Costs (Taka/CM)	2.41	2.64	2.50
RPGCL Operational Costs (Taka)	656,305,088.58	287,243,757.63	305,962,015.27
Total Costs after Regasification (Taka)	130,056,342,655.53	184,180,347,194.53	175,308,827,224.89
TDS (7% on LNG Charge)	9,789,187,081.60	13,863,036,885.61	13,195,288,070.69

(Table 11 contd.)

(Table 11 contd.)

Fiscal Year	2018-19	2019–20	2020–21
Total Costs after TDS (Taka)	139,845,529,737.13	198,043,384,080.13	188,504,115,295.58
Per Unit Re-gasified LNG Cost (Taka/CM)	42.6160	34.4731	30.8051
Per Unit Petrobangla Administration Cost (Taka/CM)	0.0550	0.0550	0.0550
Per Unit Transmission Costs (Taka/CM)	0.4235	0.4235	0.4235
Per Unit Distribution Costs (Taka/CM)	0.2500	0.2500	0.2500
Per Unit Economic Cost (Taka/CM)	43.3445	35.2016	31.5336

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited and Petrobangla.

LNG import costs account for more than 85% of the total re-gasified LNG costs. The costs breakdown of the imported LNG can be visualized from the table 12 below:

Table 12: Costs Breakdown at Different Stages

Category	Item	2018-19	2019–20	2020–21
LNG Import	LNG Import Price	71%	70%	70%
	Associated Costs	16%	16%	16%
Regasification	Regasification Costs	5%	7%	8%
	Associated Costs	7%	7%	7%
Import+ Regasification	Re-gasified LNG Costs	100%	100%	100%

Source: Authors' Illustration.

5. BANGLADESH'S GAS PRODUCTION, CONSUMPTION PATTERN, AND DEMAND-SUPPLY PROJECTIONS: IMPLICATIONS FOR IMPORT OF LNG

5.1 Bangladesh's Gas Production, Consumption Pattern, and Demand-Supply Projections

LNG import is expected to occupy an increasing supply share to meet the growing local gas requirement. Starting in 2018-19, the dependence on LNG import was 19% in 2020–21 (Table 13). The country's existing energy strategy, growing energy requirements (Table 14), energy infrastructure development[4], and demand-supply projections (Table 15) point to the growing dependence on LNG import.

Table 13: Local Gas Production and Importation of LNG

Year	Local Production (Bcf)	LNG Import (Bcf)	Total (Bcf)	Share of LNG (%)
2011–12	774	-	774	0%
2012–13	801	-	801	0%
2013–14	820	-	820	0%
2014–15	890	-	890	0%
2015–16	971	-	971	0%
2016–17	972	-	972	0%

(Table 13 contd.)

[4]There are now 11 power plants in the pipeline that will be relying on imported LNG as a fuel supply, and the combined capacity of those power plants is about 6.5 GW (sub section 3.3)

(Table 13 contd.)

Year	Local Production (Bcf)	LNG Import (Bcf)	Total (Bcf)	Share of LNG (%)
2017–18	961	-	961	0%
2018–19	965	116	1081	11%
2019–20	887	203	1090	19%
2020–21	892	216	1108	19%

Source: Hydrocarbon Unit, Energy and Mineral Resources Division.

Table 14: Sectoral Distribution of Gas Consumption in Bcf

Fiscal Year	Power	Industry	Captive	Fertilizer	Commercial	Domestic	CNG	Tea Estate	Total
2012–13	328.80	135.72	134.12	59.94	8.80	89.73	40.15	0.79	798.05
2013–14	333.37	137.61	135.98	60.78	8.93	90.98	40.70	0.80	809.15
2014–15	354.71	147.70	150.02	53.81	9.09	118.17	42.92	0.80	877.22
2015–16	399.59	155.98	160.83	52.62	8.98	141.44	46.46	0.91	966.81
2016–17	403.51	163.10	160.48	49.10	8.65	154.40	46.95	0.97	987.16
2017–18	398.59	166.53	160.51	42.97	8.17	157.93	46.19	0.94	981.83
2018–19	450.82	164.49	157.50	57.67	7.94	158.86	43.37	1.01	1041.66
2019–20	455.89	155.73	151.55	54.55	6.67	132.69	36.10	1.14	994.32
2020–21	425.70	181.75	169.05	64.65	6.02	134.17	35.07	0.98	1017.39

Source: Hydrocarbon Unit, Energy and Mineral Resources Division.

Power generation consumed 46% of natural gas, while captive power accounted for 15%, industries 16%, and fertilizer factories 5% in 2019–20 (Table 14). Thus, it is the power generation requirement that has to dictate the country's strategic stand on the energy issue.

Table 15: Daily Demand-Supply Projection in MMscf

Fiscal Year	Demand	Supply	Supply Shortage
2021–22	4224	2639	1585
2022–23	4274	2616	1658
2023–24	4331	2492	1839
2024–25	4396	2758	1638
2025–26	4467	3134	1333
2026–27	4543	3586	957
2027–28	4704	3814	890
2028–29	4853	4262	591
2029–30	5005	4703	302

Source: Gas Sector Master Plan 2017.

5.2 Cost Burden on LNG Import

As the trends and policy documents reflect, the Government of Bangladesh (GoB) wants to meet this supply gap through LNG. While the country's regasification capacity of 1000 MMscfd, it

usually supplies around 650 MMscf gas daily into the national grid. Alongside the decrease in local production, it is the sudden jump in spot LNG prices that are creating supply challenges for the country. LNG prices in the spot market increased to over $36 per MMBtu year-on-year in October 2021 from only $4 per MMBtu; last year, 2,740 MMscf of gas was extracted from the country's gas fields, which has now come down to 2,450 MMscf (Kashem, 2022). In October 2021, Bangladesh had to pay USD 36 per MMBtu for the same LNG that was only USD 7 per MMBtu in March 2021 forced to stop buying LNG from the spot market, which led to a fall in gas supply-forcing some power plants to run on oil in place of gas (Imam, 2022).

Per unit economic cost of LNG was 31.53 taka in the last fiscal year. The cost is expected to rise this fiscal year as Bangladesh already purchased LNG at a price way higher than the previous fiscal year. Petrobangla recently submitted a request to BERC to adjust the consumer gas prices as the cost of supply has increased. Petrobangla also submitted a cost estimation of gas supply for this fiscal year (2021–22) (Table 16).

Table 16: Petrobangla Cost Estimation of LNG Import for 2021–22

Item	Cost Estimation for 2021–22
Per Unit Import Price (Taka/CM)	36.69
Per Unit Import Cost (Taka/CM)	44.95
Per Unit Regasification Cost (Taka/CM)	1.85
Per Unit Re-gasified LNG Cost (Taka/CM)	50.39

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited and Petrobangla.

Petrobangla also estimated costs for national gas production. If we compare that costs estimation with the actual cost of last fiscal year, per unit LNG import cost, was about 24 times our national company production and 11 times IOC production (Table 17).

Table 17: Comparison of Import Cost with National Production

National Production (Estimated for 2021–22)		Imports in 2020–21
National Company	IOC	LNG
1.27	2.91	30.81

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited and Petrobangla

Quoting the Finance Division of the GoB, a recently published article in the Business Standard (January 2022) elaborates that the state subsidy burden going more than three times higher than the budgetary allocation amid a global price spike. The Energy Division has got only 1,000 crore taka in subsidy against its demand for 10,000 crore taka to meet LNG import bills, as claimed (Kashem, 2022). According to a recent feature of The Daily Star, while a subsidy of 6,000 crore taka has been set aside for LNG in this fiscal year, the finance ministry may increase the amount of subsidy by an additional 4,000 crore taka in the revised budget. On the other hand, the energy division sought 32,000 crore taka in subsidy if they are to meet the LNG import bills unless the government increases the price (Byron & Habib, 2022). The development probably takes the LNG import venture to the unsupportable subsidy burden. Otherwise, the costs have to be borne by the consumer groups. Users of natural gas like compressed natural gas (CNG) vehicles, hotels & restaurants, and small & cottage industries are already paying premium prices (Table 18). Petrobangla estimated price of Bangladeshi Taka (BDT) 20.36 for 2021–22 (noted in a letter to the BERC) reflects over 107% increase in the estimated price level.

Table 18: Incidences of the Weighted Average Price and Price of Natural Gas

Consumer Group	Price	Weighted Average Price	Difference
Power	4.45	9.8	-5.35
Captive Power	13.85	9.8	4.05
Fertilizer	4.45	9.8	-5.35
Industry	10.70	9.8	0.90
Tea Estate	10.70	9.8	0.90
Hotel & Restaurants	23.00	9.8	13.20
Small and Cottage Industry	17.04	9.8	7.24
CNG Feed Gas	35.00	9.8	25.20
Domestic	12.60	9.8	2.80

Source: Bangladesh Energy Regulatory Commission.

The consumer's tariff for power plants is BDT 4.45 per cubic meter. The rest of the costs for imported LNG (BDT 27.08 per cubic meter in 2020–21) is an additional cost burden. The total amount of cost burden in FY 2020–21 was amounted to be 69,346 million taka for LNG consumed in power plants (Table 19). The burden was 57,070 million taka in the fiscal year 2018–19.

Table 19: Cost Burden for LNG Consumed in Power Plants

Fiscal Year	Cost Burden (million Taka)
2018–19	57,070
2019–20	80,999
2020–21	69,346

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited, Petrobangla, and Bangladesh Energy Regulatory Commission.

6. ESTIMATION OF ENVIRONMENTAL COSTS OF IMPORTED LNG IN BANGLADESH

Estimation of environmental emissions requires a holistic approach like Life Cycle Assessment (LCA). To comment on the environmental impact of a certain fuel, one should look into the emission it produces over its life cycle. While comparing two fuels, looking into the life cycle emissions of those fuels is a must. This study identifies a supply chain of LNG for Bangladesh. Estimating environmental emissions within that system boundary is not sufficient as that boundary only covers a tiny part of the total life cycle of imported LNG. Since one of the intentions of this study is to provide policymakers with the climate change impact of LNG Import and climate change is a global issue, estimating emissions that occurred only within Bangladesh wouldn't be coherent.

The GHG emissions estimation of this study is hence considered a life cycle approach. Life cycle GHG emissions of LNG as fuel to produce electrical energy are considered to comment on the environmental cost of LNG.

National gas is considered a relatively clean source of energy as compared to that coal from an environmental perspective. Silva and Raadal (2019) found that GHG emissions in coal-fired and natural gas-fired power plants are in the range of 692.0 to 1250.0 g CO2e/kWh and 359.6 to 539.5 g CO2e/kWh respectively. In a report on Life Cycle Assessment of Electricity Generation Options by the United Nations Economic Commission for Europe (UNECE), it was also found that coal power

has a minimum of 751 g CO2e/kWh and a maximum of 1095 g CO2e/kWh emissions, whereas natural gas power combined cycle power plant can emit 403-513 g CO2e/kWh (UNECE, 2021).

While natural gas has comparatively lower GHG emissions than coal, LNG has GHG emissions close to coal. This is because of the extra processes LNG goes through e.g. liquefaction, shipping. LNG life cycle emissions can be high as 822 g CO2e/kWh (Roman-White, Rai, Littlefield, Cooney, & Skone, 2019), which is even higher than some coal-fired power plants.

In a study, life cycle emissions of exported LNG from the USA to the Asian market for electricity generation were found 655 g CO2e/kWh (Abrahams, Samaras, Griffin, & Matthews, 2015). Taking this finding as a benchmark, total life cycle emissions were estimated for LNG consumed in Bangladeshi power plants. In 2018–19, life cycle emissions for LNG consumed in power plants were 88,174 tonnes of CO2e and in 2020–21, it was increased to 158,965 tonnes of CO2e (Table 20).

Table 20: Life Cycle Emissions of LNG Consumed in Power Plants

Fiscal Year	2018-2019	2019–2020	2020-2021
Re-gasified LNG Consumed in Power Plants (Cubic Meter)	1,420,211,298	2,633,992,209	2,560,434,105
Associated Emissions (tonne CO2e)	88,174	163,532	158,965

Source: Calculated based on the data from Rupantarita Prakritik Gas Company Limited and Abrahams et al. (2015).

It is a fact that natural gas has been considered cleaner and with lower carbon dioxide emissions than coal or oil, however LNG to replace other fossil fuels is not an effective strategy to reduce GHG emissions. Moreover, the massive investments in new infrastructure to support the industry, including pipelines, liquefaction facilities, export/import terminals, and tankers, lock in fossil fuel dependence, making the transition to actual low-carbon and no-carbon energy even more difficult and complex (NRDC, 2020).

7. WAY FORWARD

Greater dependency on imported LNG is acknowledged to meet the demand-supply gap of the natural gas requirements in the power and other sectors of the country. Some recent trends and developments reflect the fact that the growing dependence on LNG from external sources to meet the essential requirement of the power sector might create threatening uncertainties to the development process of the country. In terms of price surge, LNG is found to be one of the unpredictable energy commodities, and suppliers of the long-term contracts are not showing interest in stable contractual obligations, as media reports claimed. The current Ukraine crisis and the associated diplomacy might also affect the LNG supply and price negatively for the country. The scenario might offer adequate stimulus to revisit the country's existing approach to the growing reliance on LNG imports for power generation and the associated infrastructure development plans.

There is no doubt that LNG imports to meet the existing demand-supply gap and to encounter the necessity have no immediate alternative. Rather, LNG imports and high subsidies in certain sensitive sectors must not be avoided. However, there are widespread concerns that the increasing trend of LNG in the global market might affect the country's macro-financial management with a very high subsidy burden ultimately shifting the price burden to the sensitive and vulnerable sectors. Thus, searching for local and viable options and the associated capital investments do not seem to be unjustifiable.

Bangladesh remained far behind the target of renewable energy production in the country despite strong advocacy of the potential of solar and wind energy. Especially, efforts in solar and other renewable energy sectors should deserve newer impetus in the context of the ongoing energy challenges and uncertainties. Yes, certain challenges associated with renewable energy are recognized[5], however, things are improving and newer solutions are coming up to handle the challenges.The investment costs of renewable energy technologies are generally higher compared to fossil fuel alternatives, however, it is widely acknowledged that the return on this investment is very high once externalities such as health and environmental hazards are considered. Long-term operating costs for renewable energy are also less and it is consistently decreasing. Certain less sensitive sectors might primarily be identified within an incentive framework to bring under renewable energy by phases, and it must be a long-term approach for ensuring sustainability.

In the medium to long term, Bangladesh needs to emphasize gas supply from domestic gas reserves. Bangladesh should not consider LNG import as a long-term solution, especially for the power sector. Government should put emphasis on clean energy-based power generation, gradually increase the share of renewable energy in the fuel mix, and improve energy efficiency. BPDB should revisit its existing power generation plan which is in the pipeline and should not encourage future power plants based on LNG or Oil. BPDB should redesign its future power generation plan emphasizing renewable energy-based power plants. BPDB should not allow using the land available from abandoned coal-fired power plants for establishing LNG-based power plants. The BERC should not consider increasing the gas price. An increase in gas price might be unaffordable to the low-income population/households in this critical circumstance of Covid-19. Hence, in the short-term government should take the burden.

[5]For example, limited land availability for renewable projects; subsidies to fossil fuel; short term policy approach; inadequate access to finance projects etc.

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