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To drill or, not to drill for natural gas in Bangladesh: A comparative economic and reservoir analysis

Haniyum Maria Khan[1], Mohammad Moshiur Rahman[1] Dr. Nadim Khandaker[2]
[1]*Department of Environmental Science and Management, North South University (NSU), Bangladesh*
[2]*Department of Civil and Environmental Engineering, North South University (NSU), Bangladesh*
[2]*Corresponding author: nadim.khandaker@northsouth.edu*

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Abstract

With the growing population, Bangladesh is struggling to provide energy to meet the demands of energy-dependent sectors. Bangladesh has a total of 28 gas fields which are lagging in terms of production and fulfilling national demand. The government of Bangladesh has decided to import liquified natural gas (LNG) from the international market to pace up its energy supply. Being subjected to a highly volatile market, LNG prices are unstable and quite high compared to other natural gas alternatives. This paper examines to what extent the economic investments vary between LNG import and drilling for natural gas within Bangladesh. It also analyzes the reservoir types and characteristics of potential hydrocarbon reservoirs in both onshore and offshore Bangladesh to evaluate the prospect of future drillings. The cost analysis estimates that the price of LNG import will be 14 times higher than exploring for and producing from domestic hydrocarbon resources and reserves respectively till 2030. Even in a situation with fewer (than expected) resources in the unexplored potential zones of the country, future investments in new reserves will still be profitable for the long-term development of the energy sector in Bangladesh.

Keywords: LNG economy, Bangladesh, natural gas, LNG import, sustainable exploration

Introduction

According to the World Population Review, Bangladesh ranks number eight in the list of countries and dependencies by population having an estimated population of 173 million within an area of 130,170 square kilometers. A country with such a growing population and huge infrastructural developments requires a continuous energy supply to meet

the demands of its rising appetite for energy and power (Sajid, 2022). Although energy is a prerequisite for its socio-economic development, the country suffers from a shortage of energy supply according to the various demands. In a world, where every country is committed to achieving the SDG (Sustainable Development Goal) goal number 7 which is to ensure access to affordable, reliable, sustainable, and modern energy for all, Bangladesh is still nibbling at the options for such energy sources.

The government of Bangladesh has canceled ten mega projects on coal-fired power plants to phase out coal. The country has also promised to implement nationwide mega solar projects and estimated that 40% of the nation's electricity supply would come from solar power by 2041. If no alternate source of energy is added to the board by 2041, the rest of the energy is likely to come from natural gas, nuclear power, hydropower, wind power, and other fossil fuel sources. The only hydropower and wind power plants running on the grid are the Karnafuli hydropower station and the Feni wind power station.

Similarly, Kutubdia and Patuakhli wind power projects are on the pipeline and currently being windmapped but are progressing at a snail's pace (Chowdhury, 2016). There was a target of 1370 megawatts of electricity generation from wind by 2021 but unfortunately, that didn't happen. The Rooppur nuclear power plant has also exceeded its due launching time and is unlikely to have it on the grid before 2025 (Hassan Shetol et al., 2019).

At this point, the option left for meeting the nation's energy demand is by exploring as well as producing the country's own natural gas resources or exporting LNG from the international market. In this paper, an in-depth data survey was done using the existing database of Petrobangla to conduct a time series economic and production analysis of existing gas fields in Bangladesh. Economic analysis of LNG import was also included in the LNG mass balance. A statistical time series analysis was done to complete the mass balance and to test the hypothesis that Bangladesh needs to explore more potential sources of natural gas than depend solely on the imports of natural gas to meet the present and future demand (IEEFA, 2023). Geological analysis of the subsurface of Bangladesh has also been included to further strengthen the argument. This paper begins with section 2 which identifies potential issues in the petroleum sector of Bangladesh by

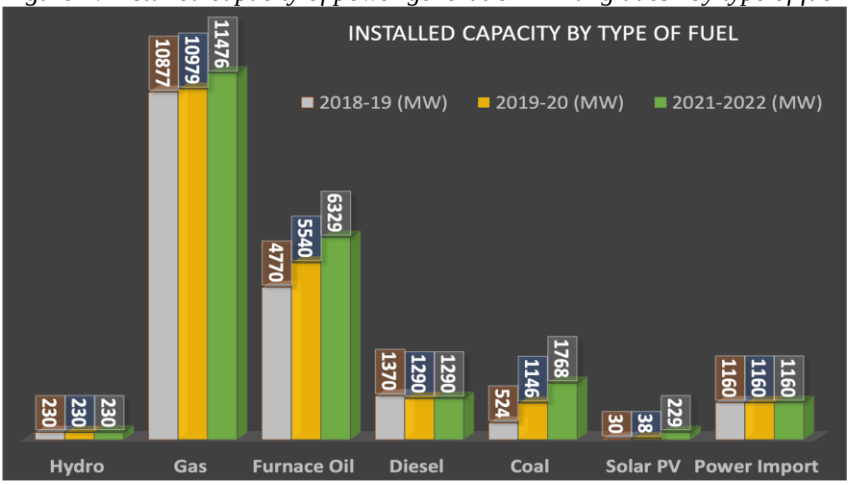
observing the present situation. Section 3 discusses the geological analysis of the onshore and offshore reserves of Bangladesh. Section 4 includes an economic analysis and comparison between domestic gas exploration and LNG import. Lastly, section 5 concludes the paper with several recommended activities for sustainable future actions in the energy sector of Bangladesh.

Potential issues in the Petroleum sector of Bangladesh

Current scenario of oil and gas in Bangladesh

At present, Bangladesh generates electricity from indigenous natural gas, coal (domestic and imported), imported oil, imported LNG, Biomass, hydropower, and solar power. The installed capacity from 2018-2022 shows (Fig-1) an overall trend of increase in natural gas, furnace oil, and coal-fired power plants. A slight increase in power generation can also be observed from solar-powered stations. However, there is an overall decrease in diesel-powered plants from 2018-2022 (BGDCL, 2022).

Figure 1: Installed capacity of power generation in Bangladesh by type of fuel

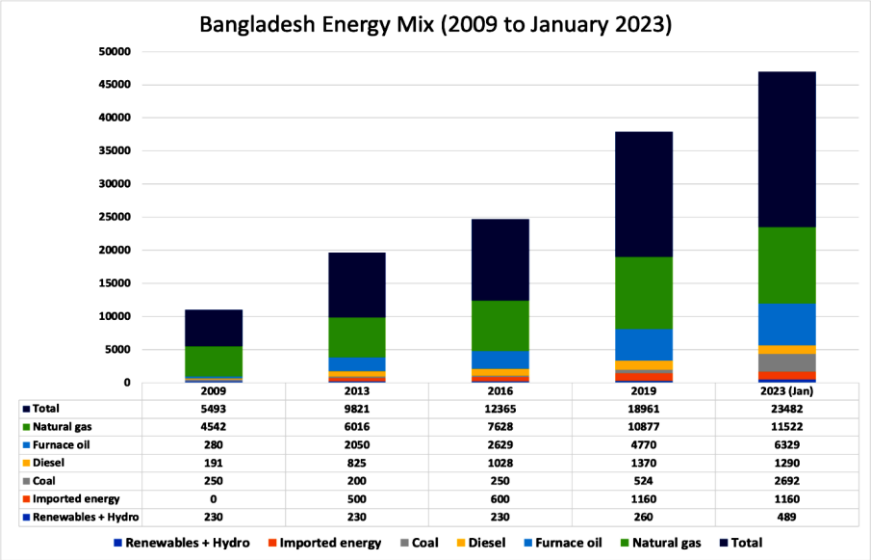


Source: BGDCL, 2022

According to the data from Institute for Energy Economics and Financial Analysis, it can be observed (Fig-2) that, the increase in solar power and

hydropower sectors in Bangladesh has been very slow from 2009 to 2023 (Jan) and only added 259 MW in 14 years. On the other hand, the electricity generation from natural gas and furnace oil has increased multifold from 2009 to 2023. Alarmingly the use of coal for power generation has also increased despite its environmental impacts. The total amount of electricity generation has gone from 5493 MW to 23,482 MW within the abovementioned timeframe (Hassan Shetol et al., 2019). IEEFA's report on electricity sector transition estimated that 49 % of the country's electricity is generated from natural gas. Furnace oil and coal have respectively 32% and 11% share in the production of electricity in Bangladesh. In a developing country like Bangladesh with humongous population pressure, the need for hydrocarbons is unlikely to recede by 2050 (BGDCL, 2022).

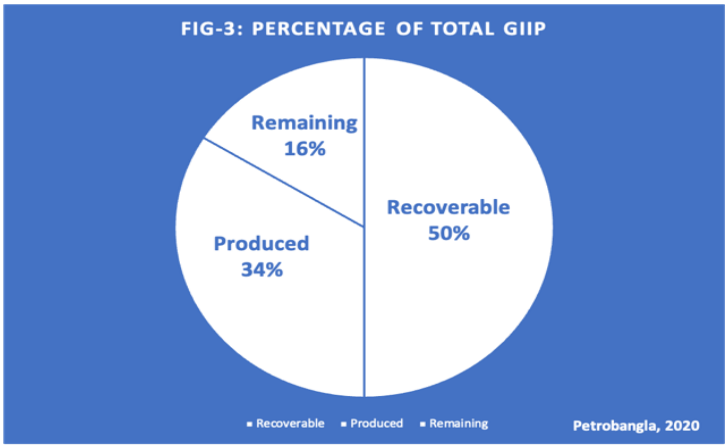
Figure 2: Bangladesh energy mix from 2009 to January 2023



	2009	2013	2016	2019	2023 (Jan)
Total	5493	9821	12365	18961	23482
Natural gas	4542	6016	7628	10877	11522
Furnace oil	280	2050	2629	4770	6329
Diesel	191	825	1028	1370	1290
Coal	250	200	250	524	2692
Imported energy	0	500	600	1160	1160
Renewables + Hydro	230	230	230	260	489

Source: IEEFA, 2023

Figure 3 : Bangladesh's national reserve for natural gas



According to Bangladesh Oil, Gas and Minerals Corporation (Petrobangla), Bangladesh has a total of 29 gas fields with the recently discovered Ilisha gas field in Bhola (The Daily Star, 2023). The annual report of Petrobangla (2020) suggested a total amount of 39 trillion cubic feet (TCF) of gas initially in place (GIIP) in Bangladesh. Among the proved and probable (recoverable) gas reserves of around 29.54 TCF, 20 TCF gas has already been produced and only 16% which accounts for only 9.54 TCF is remaining (Figure 3) for future use (Rahman, 2022). The highest producers of natural gas in Bangladesh are Titas, Bibiyana, Habiganj, Kailashtila, Rakhidpur, Bakhrabad, and Jalalabad respectively. Combinedly, they hold around 76% of Bangladesh's total gas reserve.

The statistics from Petrobangla suggests that there is an overall decline in gas reserve in domestic exploration and production companies as well as international oil companies (Fig-4). On the other hand, Bangladesh's demand for energy is increasing at an accelerated pace due to massive population pressure as well as the increasing number of mega-development projects that are underway. The country has already started to experience a decline in natural gas production in most of the gas fields (Petrobangla, 2020). The total production of natural gas in 2019 was 1010 BCF whereas the total consumption was 1110 BCF (Fig-5(a)). At this rate, by 2030, the

shortfall in production against demand will be around 3800 mmcfd approximately (Fig-5(b)). If it continues to decline like this and no discovery is made, then the domestic reserve e of natural gas will exhaust by 2030-2031 (Curiale et al., 2002).

Figure 4: Showing the initial and remaining natural gas reserve (in BCF), source (Petrobangla, 2020)

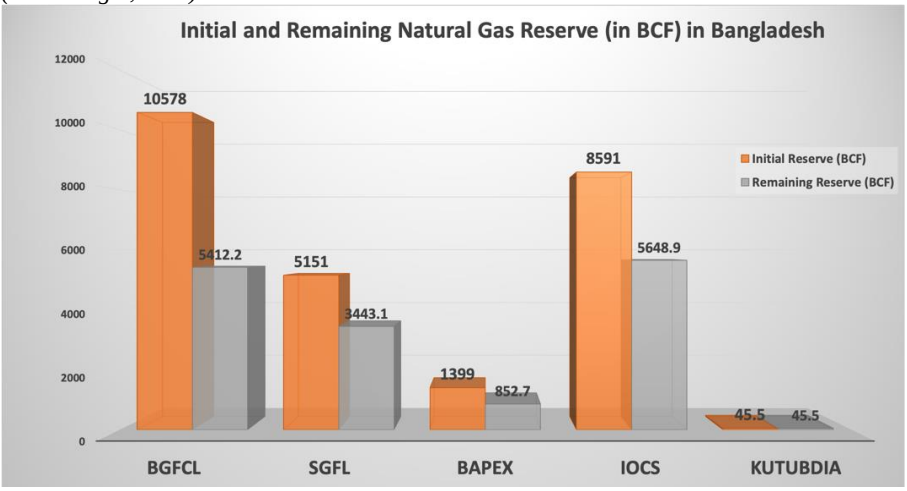


Figure 5(a): Natural gas production/consumption scenario in Bangladesh (BGDCL, 2022)

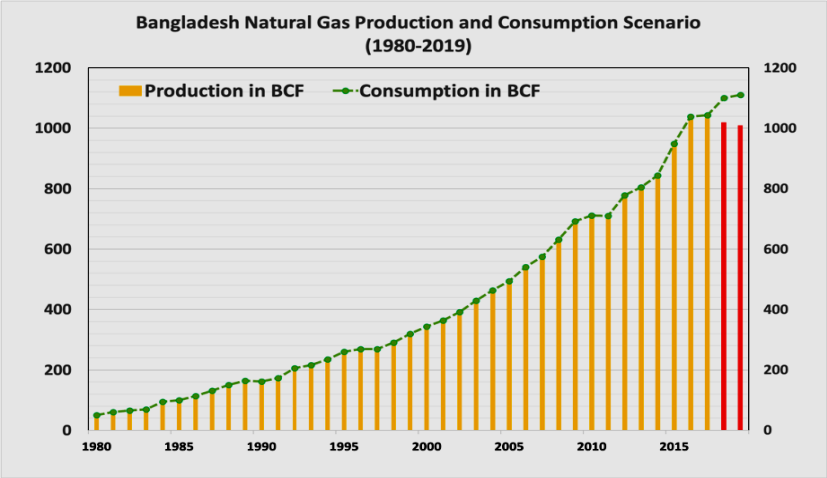
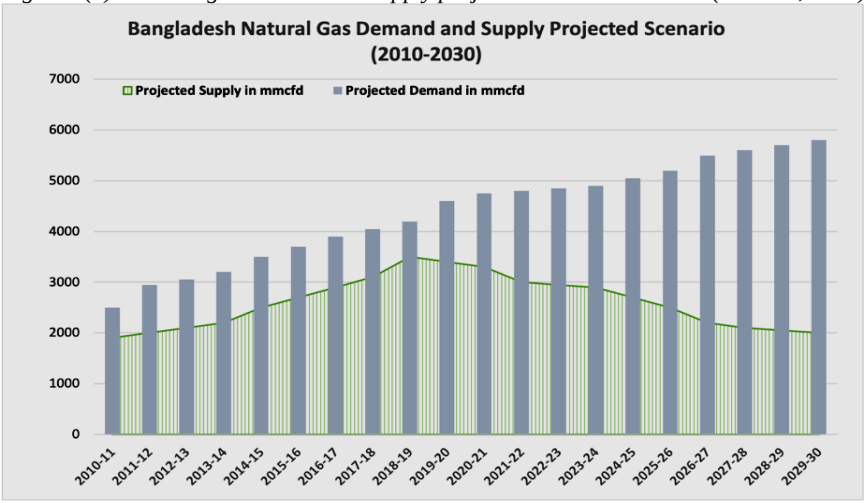


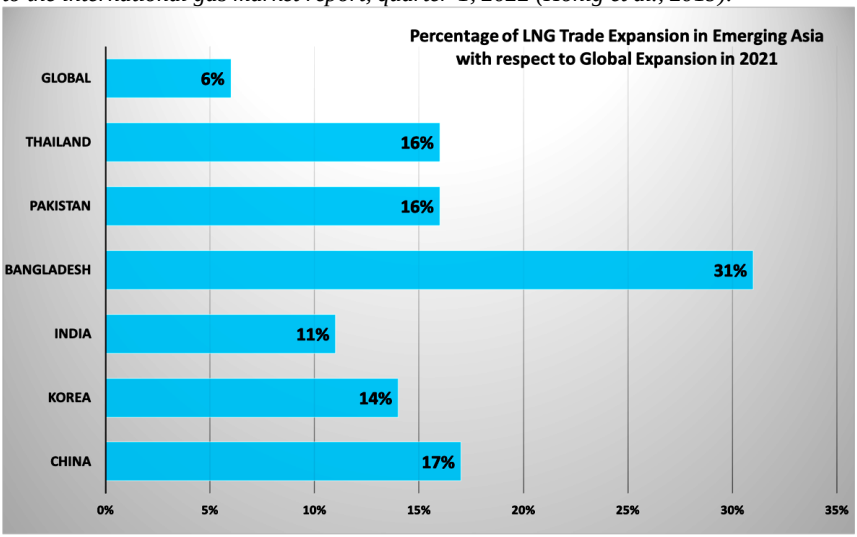
Figure 5(b): Natural gas demand and supply projected scenario till 2030 (BGDCL, 2022)



Alternatives for domestic natural gas:

The substantial shortfall of domestic natural gas gave rise to the question of finding viable alternatives. Amid the severe natural gas (NG) crisis, the only possible, if not feasible, option was to import LNG from the global market. In case of no new onshore and/or offshore discoveries, Bangladesh will have to import over 100,000 metric tons of LPG yearly which can aid in meeting the growing demand of the country as calculated by Petrobangla. In two separate agreements, the government has signed to install two floating storage and regasification units at Mohesshkhali which can supply 500 MMscfd RLNG each. There is another joint venture with Japan to construct a land-based LN terminal at Matarbari, Cox's Bazar (Hydrocarbon Unit, 2023). In 2021, the highest percentage of LNG trade expansion in emerging Asia with respect to global expansion showed that (Fig-6), Bangladesh accounted for the highest percentage (31%) of LNG import among Asian countries, leaving behind countries like China (17%), Thailand (16%), Pakistan (16%), Korea (14%) and India (11%) (Hönig et al., 2019).

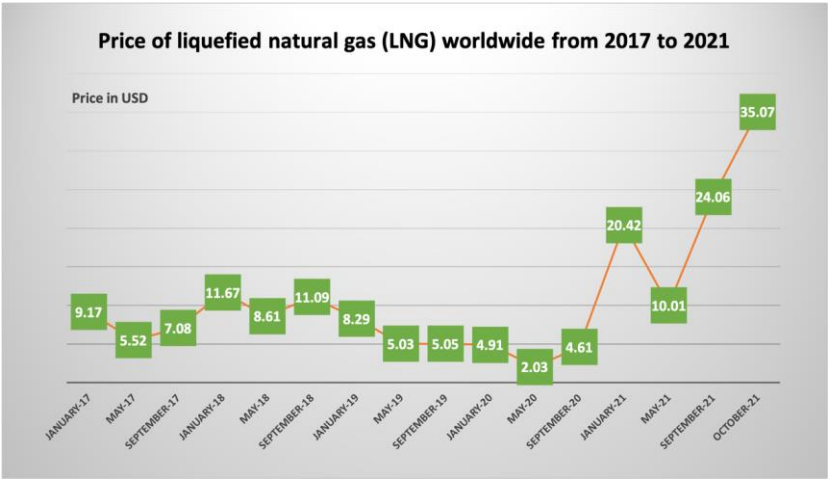
Figure 6: Showing the percentage of LNG trade expansion among Asia countries according to the international gas market report, quarter-1, 2022 (Hönig et al., 2019).



The crucial problems with the global LNG market are multifold as the global market is extremely volatile and can be impacted by several issues:

- Supply outage in case of global pandemics (BGDCL, 2022)
- Increasing demand from other countries which are phasing out of coal and moving towards greener energy resources (IEEFA, 2023)
- Significant disruption to gas prices worldwide due to the Russia-Ukraine war (Sajid, 2022)
- Unpredictable price hike of LNG in the global market over the years (figure 7) (Sajid, 2022).

Figue 7: LNG price hike from January 2017 to October 2021 (Sajid, 2022).



Therefore, introducing humongous amounts of imported LNG, in the long run, will cost a fortune for a developing country like Bangladesh. National gas prices and electricity prices will also increase in such cases. It will be difficult for the country to ensure sustainable economic growth with the amount of money spent on LNG imports.

Collaring the gas crisis with domestic natural gas exploration and production

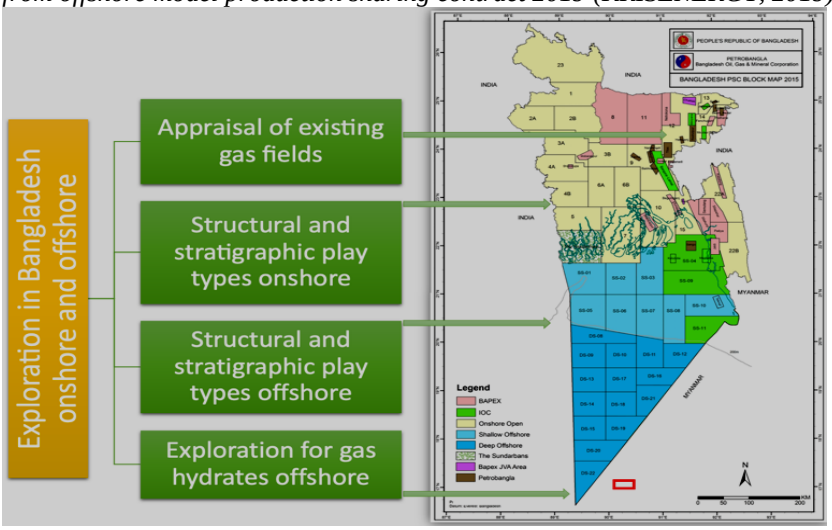
Bangladesh has been exploring hydrocarbons for not very long. Looking back at the history of gas exploration in independent Bangladesh, it can be said that, the country still has not reached an advanced state in terms of exploration. Being one of the largest deltas around the globe, Bangladesh has the potential to be a region rich in natural gas resources (Hassan & Ahmed, 2022; Rahman, 2022). For more than a decade, the exploration for new gas reserves has been very slow, almost insignificant. On the contrary, the geological analyses of the region (fig-8) suggest that there are substantial pieces of evidence of potential gas discoveries (B. Imam, 2017). The exploration can be expedited by, a) appraising the existing gas fields, b) exploring structural and stratigraphic play types onshore, c) exploring

structural and stratigraphic play types offshore, and d) exploring for gas hydrates offshore.

Appraising the existing gas fields

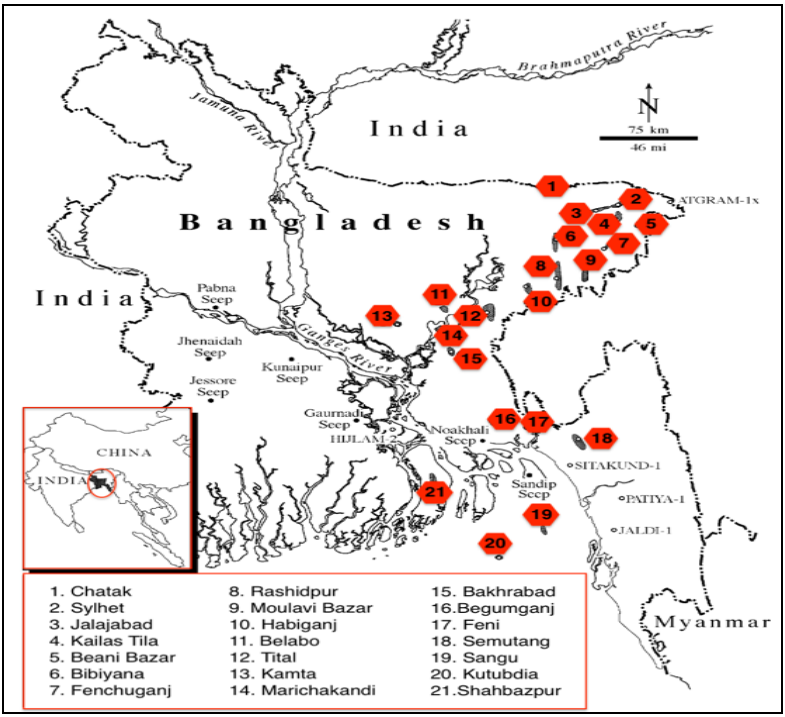
The existing gas fields including Titas, Kailashtila, Rashidpur, and Bakhrabad as well as the other smaller fields should be explored more for new undiscovered reservoir sand zones. Recently, Chevron has started drilling the flanked areas of the Bibiyana gas field to explore more gas in the extended part of the field (Dhaka Tribune, 2022). State-owned production companies like BGFCL, SGFL, and BAPEX should also start appraising their existing fields to discover new sands containing natural gas. As the only national exploration company BAPEX is now fully equipped with a 3D seismic crew, all the existing gas fields should be thoroughly surveyed to identify potential gas zones. The existing framework of wells should be utilized to perforate into the identified potential zones for testing and production (Malek et al., 2015).

Figure 8: Map showing potential hydrocarbon plays over Bangladesh, modified from offshore model production sharing contract 2019 (KRISENERGY, 2019).

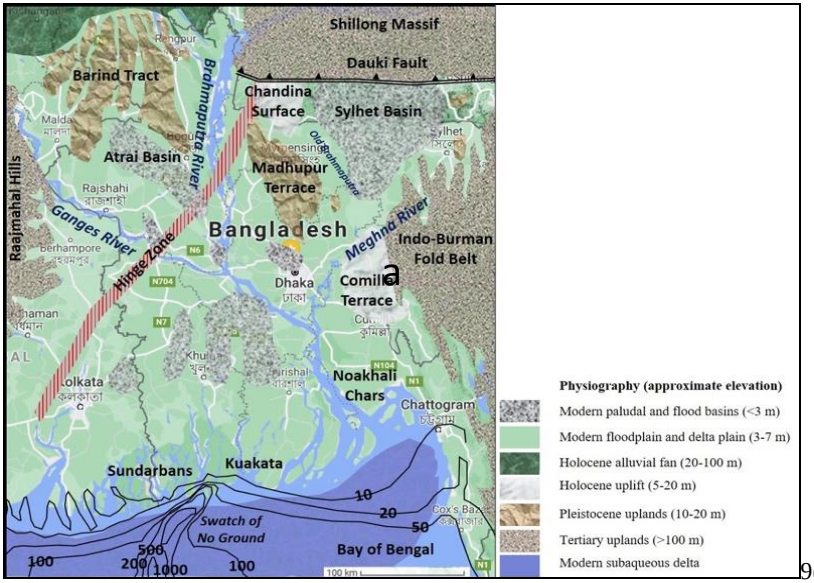


Structural and stratigraphic play types onshore:

Starting from the India-Myanmar border towards the west to the center of subsurface Bangladesh is characterized by northwest-southeast and northeast-southwest trending anticlines that are elongated in shape (Fig-9b). The structural traps in these regions are formed from the high intensity of folding and have subtle low-angle reverse faults which are thought to have added to the migration of hydrocarbons to the reservoir rocks of Miocene-Pliocene Bokabil formation in many cases. These structural traps contain most of the country's proven natural gas reserves (B. Imam, 2017).



9(a)



9(b)

Figure 9: a) Location map of Bangladesh showing the gas fields and seeps with field names, modified after Curiale et al., (2002) b) Geological map of Bangladesh with physiographic divisions, modified after Kuehl et al., (2005)Kuehl et al., 2005

Most of the wells have been drilled in areas where maximum survey data is available. In addition to that, so far, the surveys are mostly done in areas of the Surma basin where the traps are primarily structurally constructed (Fig-9a). The structural traps of Chittagong-Tripura folded belts are still not surveyed properly as seen in figure-9a. Surma basin may also still have similar structural traps that are yet to be delineated due to a lack of intensive exploration and surveying. As the compression decreases from east to west, the central structures are gentle and mildly folded. These gentle anticlines contain channel-cut Miocene sediments that are excellent examples of stratigraphic traps (Curiale et al., 2002). Moreover, the western part of the country although lacks the potential for structural traps, has greater potential for stratigraphic traps and unconventional hydrocarbon systems. These systems are characterized by reefs and growth faults as the area is very close to the Hinge zone (Ball et al., 1983). These

inland potentials and more complex hydrocarbon traps have not been surveyed or explored thoroughly. Since the advent of petroleum exploration in Bangladesh during the early 20th century, only 70 exploratory wells (both onshore and offshore) have been drilled within the country (B. Imam, 2017). Therefore, onshore gas exploration is still at a very young stage and requires serious push at present.

Structural and stratigraphic play types offshore:

In many parts of the Bay of Bengal, for instance, in India, Myanmar, Malaysia, and Vietnam, offshore hydrocarbon exploration is going on in full swing. There is a relatively much slower pace in Bangladesh's offshore region in terms of finding new resources. The adjacent Rakhine Basin, or, the Narmada Basin has seen newer discoveries in the last few years with similar structural and stratigraphic settings as the Bengal Basin (Fig-10) (Hassan Shetol et al., 2019).

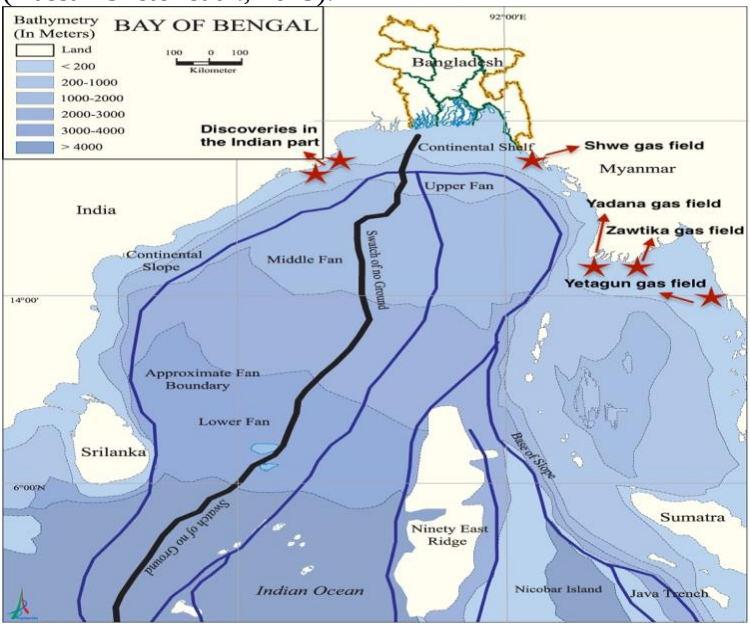
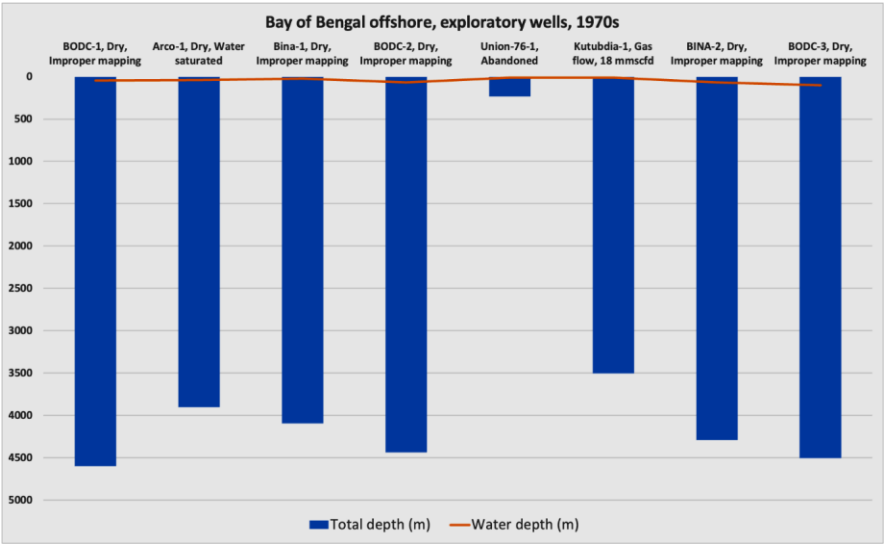


Figure-10: Giant gas field discoveries on both sides of Bangladesh offshore modified after Banglapedia Bay of Bengal map (Banglapedia, 2021)

The Bay of Bengal is consisting of a humongous volume of Tertiary siliciclastic sediments. These sediments have an approximate thickness of 20km and have different facies types like shallow marine, fluvial and deltaic (Ma et al., 2020). The offshore region is a textbook example of broad anticlinal structures having both structural and stratigraphic traps. The huge thickness of reservoir-quality sandstone and organic-rich shale at greater depths indicate that this region is highly prospective for the exploration of natural gas (M. B. Imam & Hussain, 2002).

Figure 11: Exploratory wells drilled in Bangladesh offshore in the mid-70s (Chowdhury, 2016; Malek et al., 2015).



Bangladesh's offshore exploration history dates back to the 70s (Fig-11) as per the well completion reports of Petrobangla. Bangladesh's first offshore discovery took place in 1996 when Cairn Energy discovered the Sangu gas field which started production in 1998 (Curiale et al., 2002). The production in Sangu dropped after two years due to a reduction in reservoir pressure giving rise to the concern that offshore reservoirs are more complex and require thorough 4D seismic surveys and a deep understanding of the subsurface geology. Looking at the success rates of

neighboring basins, it can be stated that the offshore region of Bangladesh is harshly overlooked in terms of exploration and mapping.

Exploration for gas hydrates:

Forming in the continental margins and deep marine sediments, gas hydrates are crystalline solids made up of hydrogen-bonded water crystals with gas molecules trapped inside. On both sides of the Bangladesh Exclusive Economic Zone (EEZ) gas hydrate accumulations have been discovered both in the Indian offshore region and the Myanmar offshore region. A joint study by the University of Southhampton, Norwegian Geotechnical Institute, Petrobangla, BAPEX, and the Bangladesh Ministry of Foreign Affairs examined seismic inversion data which clearly shows pieces of evidence of occurrences of gas hydrates in offshore Bangladesh. The seismic profiles indicate the presence of seismic traces of gas hydrates located near the slope at about 1300-1900 m depth (Monteleone et al., 2022). However, further studies are required to exactly delineate the structural condition for migration pathways and reservoir characterization. Nonetheless, these initial analyses are very encouraging to explore gas hydrates in Bangladesh offshore as the country is in dire need of future energy security (Monteleone et al., 2022).

Economic analysis comparing the cost of drilling versus the cost of LNG import

Bangladesh's annual consumption of natural gas is approximately 1 TCF. A depleting total reserve of 9.54 TCF can only support the energy sector for a maximum of 9-10 years. Over the last two years, the production of natural gas has been reduced to 286.4 mmcfd. The existing gas fields will be exhausted within the next 10 years. The total shortfall of natural gas would be 25 BCF by 2030 which is equivalent to 25000000 MMBtu of LNG. Considering the latest total cost per cubic meter of LNG import (calculated using 50 USD per cubic meter) the total cost for importing LNG (till 2030) to account for the shortfall would be 594.3 billion USD which includes purchase cost, import cost, and economic cost (SREDA, 2016). On the other hand, the minimum exploration and appraisal to

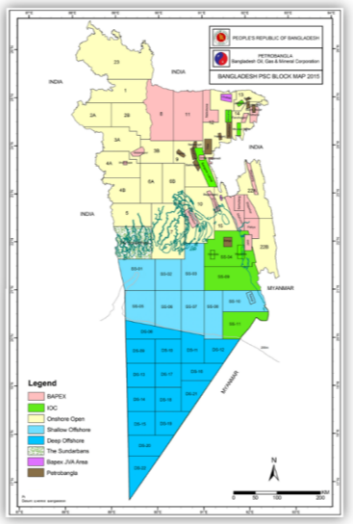
expedite the current situation and to fill up the shortfall by 2030, drilling a total of 45 wells onshore and offshore would cost approximately 41.69 billion USD (Fig-12) (Hassan & Ahmed, 2022).

Figure12: Detailed cost for exploratory wells (onshore and offshore) and development wells (onshore) (Hassan & Ahmed, 2022; Malek et al., 2015; SREDA, 2016).

Domestic Natural Gas Exploration and Production Cost

Minimum exploration and appraisal to expedite the current situation and to fill the shortfall of 25 BCF of NG by 2030

No of Wells	Types of Wells	Approximate cost
15	Exploratory Wells (onshore)	8.25 billion USD
10	Development Wells (onshore)	15.84 billion USD
20	Offshore (shallow and deep) Wells	17.6 billion USD
Total	**45 Wells onshore and offshore**	**41.69 billion USD**



From the above cost calculations, it can be observed that the cost of LNG import will be 14 times higher than exploring for and producing from domestic hydrocarbon resources and reserves. As Bangladesh is at the peak of its development activities, the sustainability of economic development must address this issue as early as possible. The government of Bangladesh should expedite domestic gas exploration activities to minimize the cost of LNG import from a highly volatile global market. This will strengthen the national economy and result in skilled manpower in the energy sector.

Conclusion

Bangladesh is going through a gas crisis at present which is adversely impacting the economic development of the country. Although the energy sector is moving towards a mix of multiple sources of energy like natural gas, coal, oil, LNG, biomass, hydropower, and renewables, the major share of energy will still come from natural gas in the next couple of years. The depleting domestic natural gas reserve is putting pressure on the economy as LNG is being imported from an extremely unstable global market at a very high price. However, the country has yet to explore its onshore and offshore blocks for natural gas and gas hydrate occurrences. According to Shell Oil Company, USGS-Petrobangla joint study, and NDP-Bangladesh joint study, Bangladesh still has 32 to 41 TCF of undiscovered gas both onshore and offshore. It is a matter of urgency to explore more conventional and unconventional resources on land and in the sea.

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