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Seminar on
Energy Security for Bangladesh- Need to Look for and Develop Alternative Sources of Energy

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NATIONAL DEFENCE COLLEGE BANGLADESH

Seminar on
Energy Security for Bangladesh-Need to Look For and Develop Alternative Sources of Energy

Organized for
National Defence Course 2023
by National Defence College
on 07 June 2023

NATIONAL DEFENCE COLLEGE
BANGLADESH

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Foreword

As Bangladesh emerges as a rapidly developing nation, its energy consumption has surged significantly. In recent years, the country has made notable strides in infrastructural development. As development and energy are intricately linked, the country faces a growing demand for energy amidst its rapid progress. Consequently, 'Energy Security' has become a pressing concern for policymakers. While there is no universal definition of energy security, it generally refers to ensuring access to clean, reliable, and affordable energy services for various needs, including cooking, heating, lighting, and economic activities. It's often assessed through the prism of "four As": Availability, Accessibility, Affordability, and Acceptability.

The energy crisis and exploration of alternative energy sources are critical issues in Bangladesh. The country is still grappling with the economic fallout from the Covid-19 pandemic as well as the Russia-Ukraine and Palestine-Israel conflict. We are experiencing a continuous drain on foreign exchange reserves and the devaluation of its currency. The power and energy sectors have been particularly affected due to their heavy reliance on imported fuels. While efforts have been made over the past decade to enhance power generation capacity, sufficient attention has not been given to overall energy sector development.

Given the circumstances, policymakers may need to reconsider the existing energy policy framework or devise new strategic policies to address the crisis and ensure future energy security in line with the government's objectives. Decision-making should consider the broader context, not just short-term crises, with policies designed with the future in mind. To address factors contributing to the current power supply challenges, it's essential to evaluate the present energy scenario and address infrastructure deficiencies. Meanwhile, renewable energy emerges as a sustainable solution to mitigate the power crisis, integrating seamlessly into Bangladesh's energy framework and fostering sustainability and socio-economic growth. Additionally, if required, the government could also make a provision for regular revision of energy policies.

I am honored to contribute this foreword for the proceedings on "Energy Security for Bangladesh - Exploring and Developing Alternative Energy Sources." My heartfelt appreciation goes to the faculty members and college staff for their diligent efforts in organizing this seminar. I also commend the Research and Academic Wing for their dedicated work and the Editorial Board for their commitment to presenting the seminar papers.

Lieutenant General Md Saiful Alam
Commandant
National Defence College, Bangladesh

Editorial

The 2030 Agenda for Sustainable Development, adopted by all the member states of United Nations in 2015, provides a shared blueprint for peace and prosperity of the people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve quality of life, health and education, reduce inequality, and spur economic growth - all while tackling climate change and working to preserve our oceans and forests.

The seventh of the 17 goals calls for ensuring access to affordable, reliable, sustainable and modern energy for all. Energy security is defined as the ability of a country to ensure adequate, affordable as well as a consistent supply of energy for use in domestic, military, industrial and transportation sectors. Energy security further relates to present and future requirements of energy and ensure that energy deficiency never takes place for the consumers despite critical situations such as political instability and economic crisis.

There is a relationship between energy and development. For any country, affordable energy, especially access to electricity, enables better health care, improved education, and greater food production. Infant mortality decreases, life expectancy increases, living standards improve. In the present time, citizens live longer, and earn a better living. In developing countries like Bangladesh, massive population growth, huge influx of people to cities, excessive water use, and increased numbers of automobiles are combining to make energy security the critical challenge of our time. In short, more development would require more energy.

In fine, I convey sincere thanks and deep felicitation to all concerned for their invaluable efforts and delicate suggestions in enriching the paper. Moreover, I would like to thank Editorial Board for their relentless support and assistance in publishing this paper. I pledge to continue this endeavor to introduce more diverse and newer topics to the potential readers.

Brigadier General A B M Shefaul Kabir
College Secretary
National Defence College

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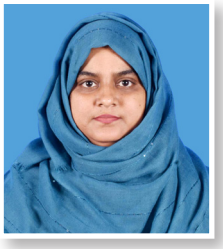

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Contents

Overview of the Seminar

As part of the course curricula, National Defence College (NDC) arranges a good number of seminars and other individual and group research works for the course members.

The seminar on 'Energy Security for Bangladesh - Need to Look for and Develop Alternative Sources of Energy' was held at NDC on 07 June 2023 as part of the course curricula of National Defence (ND) Course 2023. The seminars were participated by eight groups of Course Members of ND Course 2023 from four different syndicates. All groups presented their keynote papers on 14 May 2023 and critique groups provided their comments and suggestions to respective groups. Finally, a group of twelve Course Members were selected for a central seminar. They looked at the findings of the previous seminar, analyzed the critique, and conducted a thorough research on the topic guided by a Senior Directing Staff and a resource person. Finally, the team presented the Keynote paper on 07 June 2023 before a large gathering.

The panel of presenters covered four sub-themes, namely: Current Global and Bangladesh Energy Scenario, Likely Alternative Sources of Energy for Bangladesh, Challenges of Developing Alternative Energy in Bangladesh, and Suggestive Measures for the Long Term Development of Energy Sector in Bangladesh.

Lieutenant General Md. Akbar Hossain, SBP, BSP, SUP (BAR), afwc, psc, G+, PhD, Commandant, National Defence College has kindly consented to grace the seminar on 07 June 2023 as Chief Guest. Professor Dr. Mohammad Tamim, Bangladesh University of Engineering and Technology and all Senior Directing Staffs of National Defence College were also present.

The topic of the seminar was very much effective for the present context of Bangladesh. All the keynote speakers upheld important sides of the themes and the discussion contributed a lot to fulfill the aim of the seminar. At the end of the presentation there was an interactive session where Commandant NDC, Resource Person, Sponsor Senior Directing Staff, Faculty, invited guests and all Course Members of National Defence Course 2023 participated and contributed.

Executive Summary

Bangladesh is one of the fastest growing economies of the world which is striving to become a developed country by 2041. Energy would be one of the prime movers to attain Bangladesh's aspiration of Vision 2041. Bangladesh has promulgated 'Power Supply Master Plan (PSMP)- 2016' and promulgation of 'Integrated Energy and Power Supply Master Plan' is on the way. These have clearly manifested the forecasted demand and energy mix which needs to be attained by 2041. Bangladesh needs to transform its energy sector to greener, more environment friendly from its fossil fuel dependent one. Bangladesh's energy sector, which is predominantly based on its natural gas, is going to face a serious challenge as it is diminishing very rapidly. The overall scenario is further perplexed by post-COVID recession, price hike of fossil fuel emanating from Russia-Ukraine war and inflation caused by both. There are enormous opportunities in renewable and green energy in the world today and most of the western and modern countries are moving to that direction very rapidly, even our closest neighbour, yet Bangladesh has to do a lot in short, mid and long term.

Bangladesh cannot overthrow its dependency on fossil fuel right away, but over the period of time it has to be reduced substantially, renewable and greener energy mix will have to be implemented over mid and long term. In doing so, wind, solar, nuclear energy would suit Bangladesh better while natural gas and coal with varied proportion would remain as major part in the energy mix. Cross border energy trade with neighbours would also be an option to meet balance of the energy requirement. To attain its energy security, Bangladesh has to revisit its energy mix, overhaul its generation, transmission and distribution system. Integrated regulatory framework, policy implementation, accountability, capacity building of local government agencies, energy conservation etc. would be necessary to achieve its goal.

After analysing various factors, options and challenges of alternative energy, following were the key recommendations of the Seminar:

- Solar energy is the most potential alternative energy source for Bangladesh. Ongoing efforts such as SHS, Solar irrigation, Rooftop Solar Panels, Solar micro/Mini Grid should be encouraged. Conversion of 0.3 million out of 1.6 million irrigation pumps into solar pumps by 2030 and another 0.5 million by 2041 to be done. Rooftop solar system to be fixed in at least 5 large industrial complexes of all 100 EPZs each by 2030 and in another 5 each by 2041. Rooftop solar systems to be made compulsory for schools, colleges, and office complexes by 2030. By 2041, spaces of 10 abandoned coal power plants, leftover spaces of Pyra and Rampal power plants, and uncultivable spaces of CHT and Char areas of plain lands are to be used for establishing solar parks.

- By 2024, Net-Metering across all households, industries, Schools, Colleges, and Office complexes to be introduced; and completion by 2030 to be ensured.

- The policy makers need to decide on the use of large reserve of domestic coal.

- By 2041, Bangladesh may establish 5 Small Modular Reactors of 540 MW capacity each totaling 2700 MW.

- Cross-border power import to be increased up to 18 % (10,212 MW) by 2041. Import diversification may be done with 8% (4500 MW) power import from India and 5% (3000 MW) from Nepal and Bhutan. Considering the huge potentials, around 5-6% cross border power (around 3500 MW) is recommended to be imported from Myamnmar.

- Energy mix proposed in PSMP 2016 is recommended to be reviewed. In the mid-term (2030), Bangladesh needs to reduce dependency on Oil from 14% to 7% and Coal from 30% to 23 % and enhance the contribution of Solar, Wind and Waste to energy from 4.5% to 14 %. In the long term (2041) Bangladesh needs to reduce the oil dependency to 1%, Coal to 20%, and increase contribution of renewable to 20% and cross border power import to 18%.

- Smart Grid System to be introduced in all City Corporations by 2030.
- QR plants have lost their relevance and have become white elephants and these may be retired gradually. New contract with private sector in the form of Public Private Partnership for large scale low fuel cost power plants need to be undertaken.
- Gas being the largest source of primary energy, on-shore and off-shore gas exploration may be started immediately. IOCs may be involved in gas exploration in short term, but in the long term, the capability of BAPEX to be enhanced for gas exploration, may be in the form of joint venture.

LIST OF ABBREVIATIONS

Abbreviation	Meaning
ADB	Annual Development Programme
BAPEX	Bangladesh Petroleum Exploration and Production Company Limited
BBIN	Bangladesh, Bhutan, India and Nepal
BCAS	Bangladesh Centre for Advanced Studies
BCSIR	Bangladesh Council for Scientific and Industrial Research
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BPC	Bangladesh Petroleum Corporation
BPDB	Bangladesh Power Development Board
CHT	Chattagram Hill Tracts
CO2	Carbon Dioxide
COP	Conference of the Parties
DNCC	Dhaka North City Corporation
EPZs	Export Processing Zones
FOREX	Foreign Exchange
FY	Financial Year
G2G	Government to Government
GDP	Gross Domestic Product
GHG	Green House Gas
GIIP	Initial Gas in Place
GoB	Government of Bangladesh
HFO	High Furnace Oil
Abbreviation	Meaning
HSD	High Speed Diesel
IAEA	The International Atomic Energy Agency
IDCOL	Infrastructure Development Company Limited

Abbreviation	Meaning
IEA	International Energy Agency
IEPMP	Integrated Energy and Power Master Plan
IPP	Individual Power Producer
JV	Joint Venture
KUET	Khulna University of Engineering and Technology
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
mmcfd	Million Cubic Feet Per Day
MMCFD	Million Cubic Feet of Gas Per Day
MTOE	Million Ton Oil Equivalent
NPP	Nuclear Power Plant
NREL	National Renewable Energy Lab
PGCB	Power Grid Company of Bangladesh
PP	Power Plant
PSMP	Power Sector Master Plan
PV	Photovoltaics
QR	Quick Rental
RE	Renewable Energy
RMG	Ready Made Garments
RNPP	Rooppur Nuclear Power Plant
SDGs	Sustainable Development Goals
SHS	Solar Home System
SMRs	Small Modular Reactors
SREDA	Sustainable and Renewable Energy Development Authority
TCF	Trillion Cubic Feet
UMM	Under Mining Method
UNFCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development

Speech of the Sponsor Resource Person

Professor Dr. Mohammad Tamim

Former Advisor to the Caretaker Government and Professor of Petroleum and Mineral Resources Engineering, BUET

Bismillahir Rahmanir Rahim

It is with deep gratitude that I extend my appreciation for conducting the seminar on energy security. Our collective engagement in discussing the intricate topic of energy and power in Bangladesh is emblematic of our shared commitment to address pressing challenges in the nation's evolving landscape.

I extend my heartfelt thanks to the National Defense College (NDC) for providing a platform to deliberate on this crucial subject matter. The current context in Bangladesh accentuates the urgency and relevance of our discussions around energy - a domain that epitomizes dynamism, complexity, and perpetual change.

The culmination of this seminar, marked by the extensive efforts and dedicated contributions of numerous officers, reflects a rigorous and meticulous process. The collaborative endeavors of the four syndicates and mentors have resulted in a presentation that embodies meticulous planning, exhaustive deliberation, and insightful perspectives.

The evolving nature of energy dynamics necessitates an adaptive approach- one that acknowledges the fluidity of objectives, changing requirements, and evolving means. Climate change has propelled a significant shift from fossil fuels to renewables, compelling us to make conscientious lifestyle choices in response to the unprecedented challenges, such as enduring heat waves, that Bangladesh faces today.

Central to effective planning is the comprehensive understanding of the entire energy value chain, starting with the critical aspect of demand forecasting. The intricacies of forecasting demand underscore the complexity of energy planning, demanding multifaceted solutions in our pursuit of sustainable energy provision.

The discourse on private versus public sector involvement in the energy domain reveals nuanced realities. While acknowledging the efficiency disparities between them, it becomes evident that a well-structured approach to private sector engagement, exemplified by successful investments like AES Haripur and AES Meghnaghat, has significantly bolstered Bangladesh's power supply.

The imperative for private investment becomes apparent considering the limitations of government resources. However, this necessitates robust regulatory frameworks, good governance, and balanced contractual agreements to ensure equitable partnerships and sustainable growth in the sector.

Moreover, the overlooked but critical aspect of primary energy planning requires heightened attention. The focus on electricity generation often eclipses the need for primary energy planning - a crucial oversight that requires immediate rectification.

While harboring lofty ambitions and innovative ideas, we must temper them with practicality. The quest for viable solutions should account for the complexities of implementation within the Bangladeshi context.

In closing, I extend my heartfelt congratulations to the course members for their invaluable contributions to today's presentation. As we navigate the challenges and opportunities in Bangladesh's energy landscape, let us strive for solutions that are not only visionary but also pragmatic and implementable.

Thank you for your unwavering commitment to chart a sustainable future for Bangladesh's energy and power sector.

Keynote Paper Presenters

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Abu Hena Mohammad Razi Hasan
SUP, SPP, psc

Brigadier General
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Joint Secretary
Md. Aminul Islam

INTRODUCTORY NOTE ON ENERGY SECURITY FOR BANGLADESH- NEED TO LOOK FOR AND DEVELOP ALTERNATIVE SOURCES OF ENERGY

Introduction

Securing sustainable sources of energy is an important strategic priority for all nations including Bangladesh. Bangladesh economy has grown consistently high over a decade with almost 7% GDP growth (Finance Division, Ministry of Finance, 2022). With an estimated size of the economy reaching $1 trillion by 2040 even with GDP growth rate of below 5%, (Dhaka Tribune, 2023) Bangladesh is aspiring to be an upper middle-income country by 2030 and a High-Income Country by 2041 (Bangladesh Planning Commission, 2020). One of the main driving forces behind the country's phenomenal growth is energy and power. With the expected growth of urbanization and industrialization in Bangladesh, the demand for energy is expected to rise in future. According to the PSMP 2016, a significant rise in demand of power and energy will be observed with 31,120 MW in 2030, and 56,734 MW in 2041.

While Bangladesh has made significant progress towards energy security and increases its electricity generation capacity, it still falls short of meeting the country's growing demand for power. The energy sector is presently characterized by a blend of conventional and contemporary energy sources, with fossil fuel, mainly natural gas serving as the primary fuel. A large portion of energy and power need of Bangladesh is met by import which comes with its own challenges. Moreover, the vulnerability of our energy security was exposed during Russia- Ukraine war. Even the displacement of one of the Floating Storage Regasification Units that holds the imported LNG during Cyclone Mocha sent disruptive waves throughout the energy and power sector of the country. This leaves scope for improving the energy and power sector and integration of renewable energy sources into the grid.

The current global energy scenario is characterized by a mix of different energy sources, with the world still heavily reliant on fossil fuels for its energy needs.

If we continue like this then the world is going to face severe consequences of the Greenhouse effect such as extreme weather events like hurricanes, droughts, floods, heat waves, and rise of sea level which have severe socio-economic impacts. There is a consensus now to take measures in order to prevent this. Lately, a total of 196 countries have signed the Paris Agreement adopted in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), which primarily focuses on addressing climate change and reducing greenhouse gas emissions by moving towards renewable energy.

Bangladesh wants to produce 10% power from renewables by 2030 and set a target of generating 40% power from renewables by 2041. To attain this, Bangladesh is expected to create a robust energy mix, predominantly with greener energy, as it plans to expand power sector and transition to a clean and climate resilient economy. Changing the energy mix from a predominantly fossil fuel to renewable one is not an easy task, neither is it going to be possible within near future. As such, the keynote paper aims to analyse the current global and Bangladesh's energy scenario and explore the likely alternative sources of energy feasible for Bangladesh. The paper will suggest measures for the long term development of energy sector of Bangladesh after analyzing the challenges prevailing. Although 'Alternative Energy' and 'Renewable Energy' are often used interchangeably, for our purpose, we shall focus on alternative to Coal, Oil, Natural gas as sources of energy that may be either renewable or nonrenewable.

KEYNOTE PAPER-1

CURRENT GLOBAL AND BANGLADESH ENERGY SCENARIO

Global Energy Scenario

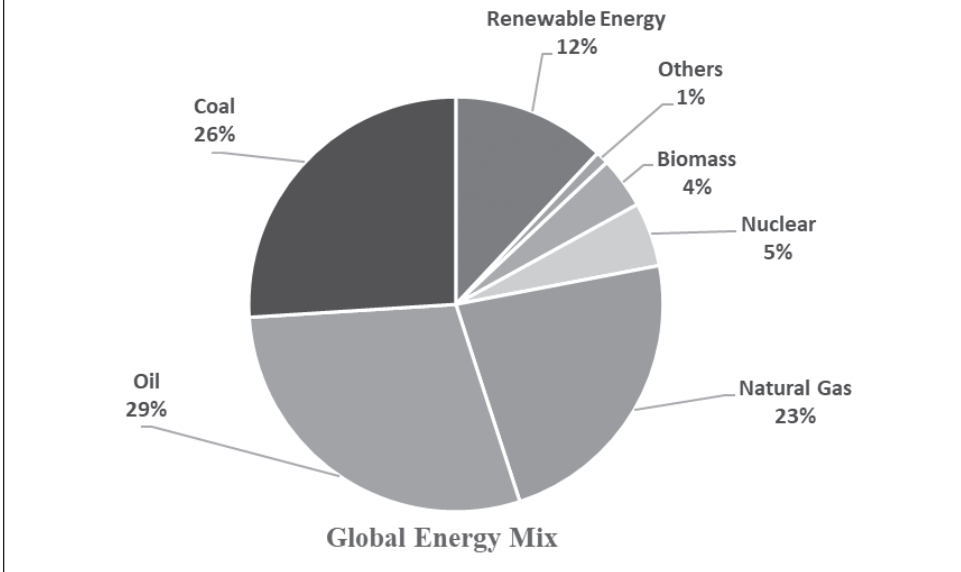
General. Global energy consumption has been steadily increasing over the past decades, driven by population growth, urbanization, and economic development. According to the IEA, global energy demand has grown by 4.6% in 2022, after a decline of 4% in 2020 due to the COVID-19 pandemic. Fossil fuels, including coal, oil, and gas continue to dominate the global energy mix, accounting for 78% of primary energy consumption in 2021 (World Energy Outlook, 2022). However, the share of renewables, including hydropower, wind, solar, and bioenergy, is growing rapidly, reaching 16% in 2021 (Figure 1). The developed countries are investing heavily and rapidly in greener energy, due to their economic capabilities. On the other hand, developing countries experience unique challenges in meeting their growing energy demands while balancing economic development and environmental concerns.

Renewable Energy. Renewable energy is becoming an increasingly important part of the global energy mix, driven by declining costs, technological advancements, and policy support. The IEA projects that renewables will account for 30% of global electricity generation by 2024, up from 26% in 2018 (IEA 2021). Globally, solar power is one of the fastest-growing renewable energy that rose from 1.5 GW in 2006 to 714 GW in 2020. Wind power is also growing rapidly, with installed capacity increasing from 74 GW in 2006 to 743 GW in 2020, according to the IEA (IEA 2021). Hydropower is one of the oldest forms of renewable energy and currently accounts for around 16% of global electricity generation.

Nuclear Energy. Nuclear energy is a contentious source of energy, with low carbon emissions, while critics point to the risks of nuclear accidents and the challenge of managing nuclear waste. Nuclear energy currently accounts for around 5% of the global energy mix, with the majority of nuclear power plants

located in the United States, France, and China (World Energy Outlook, 2022). Figure 1 explains the composition of the global energy mix.

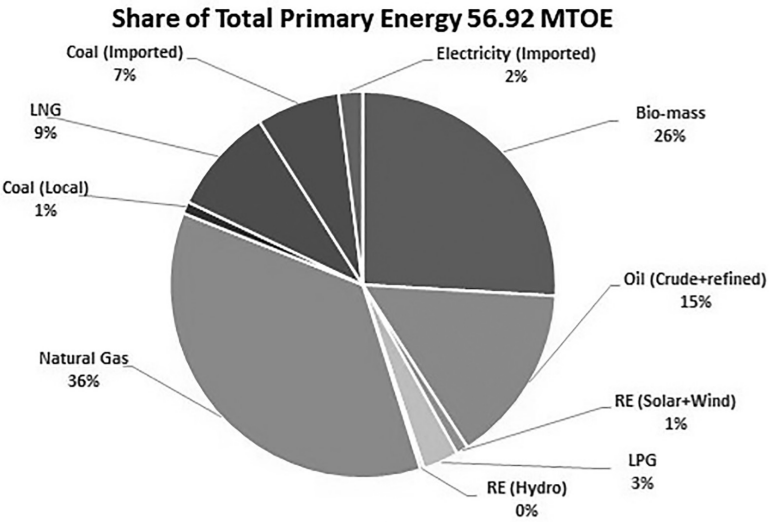
Figure 1: Global Energy Mix



Source: World Energy Outlook 2022

Energy Scenario in Bangladesh. Bangladesh started its journey in the energy sector in 1972 with an installed capacity of around 200 MW and only 3% of the total population having access to electricity. In 2022, our installed capacity stood at 22,066 MW and access to electricity stood at 100%. The energy consumption in Bangladesh in FY 2020-21 was 56.92 MTOE which is expected to rise up to 60 MTOE in 2030 and 97 MTOE in 2041 (PSMP,2016). The per capita electricity consumption in a developed country like USA is 12,321 kWh, in a developing country like India is 1,161 kWh, whereas our one is 454 kWh. Known commercial energy resources in Bangladesh include natural gas, coal, imported oil, LPG, imported LNG, imported electricity, solar, bio-mass and hydro-electricity.

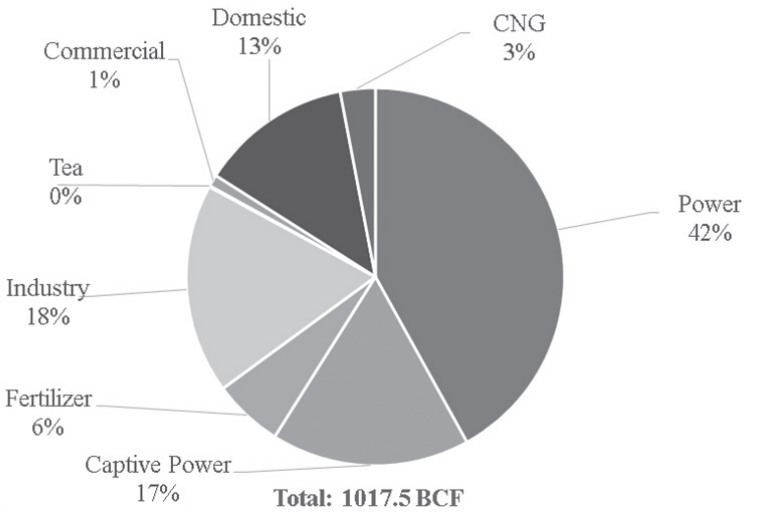
Figure 2: Share of Total Primary Energy of Bangladesh



Source: HCU 2021 pp 2

Natural Gas. Till now, 28 gas fields have been discovered in the country. According to the estimation of Petrobangla total initial gas in place (GIIP) is 39.90 TCF, out of which a total of 19.11 TCF gas has already been consumed leaving 9.30 TCF recoverable gas (Bangladesh Economic Review, 2022). Moreover, daily gas production is gradually decreasing whereas the demand for gas is increasing day by day. The daily gas consumption in the country currently stands at 3,126 mmcfd. Of this, 2,284 mmcfd of gas is generated from domestic sources, while the rest is imported from the Middle East in the form of LNG. In 2020, the local fields produced 2,570.4 mmcfd. Within a span of two years, local gas production has come down by 286.4 mmcfd. Considering the current average daily production, it will be possible to use the remaining gas for approx. 9-10 years. The power sector is the largest consumer of gas (Figure 3).

Figure 3: Category-wise Gas Consumption

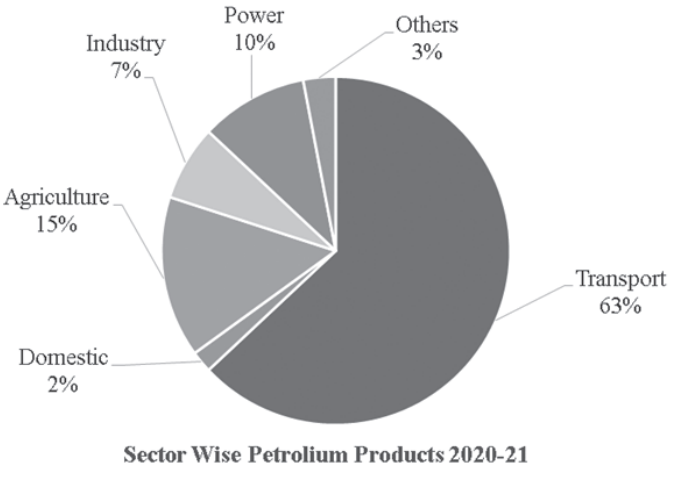


Source: Bangladesh Economic Review 2022

Liquefied Natural Gas (LNG). Bangladesh currently imports about 300 million-400 million cubic feet of LNG daily (Reuters, 2023) to mitigate the shortage of domestic gas supply. Bangladesh had to import LNG from the spot market at an unprecedented price during Russia-Ukraine War in the absence of any long-term energy deals with exporting nations.

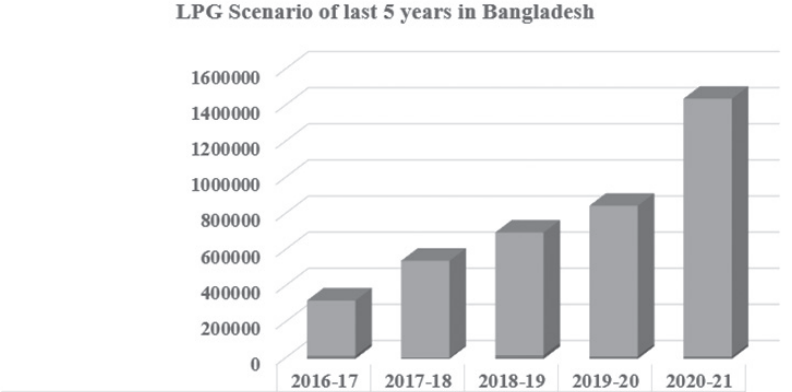
Petroleum Products. In FY 2020-21, Bangladesh imported around 1.435 million MT of crude oil and 4.2 million MT of refined petroleum products. The lone domestic liquid energy source in oil is the natural gas condensate which is produced about 0.52 MT per year (Kailashtila, 2023). Figure 4 shows the sector-wise petroleum products consumption.

Figure 4: Sector-wise Liquid Fuel Consumption in Bangladesh



Liquefied Petroleum Gas (LPG). In FY 2020-21, Bangladesh produced 13,461 MT LPG through public sector and 1,427,826 MT LPG was imported through private entities (HCU, 2021).

Figure 5: LPG Scenario in the Last Five Years in Bangladesh



	2016-17	2017-18	2018-19	2019-20	2020-21
Import (Private) MT	307000	537686	681036	835027	1427826
Public Sector Production MT	16382	5936	19228	13414	13461

Source: HCU 2021, pp 23

Coal. The total estimated reserves of the coal fields are about 7,823 MT which is equivalent to 185 TCF of natural gas. Out of these 5 coal fields, coal is being commercially extracted only from Barapukuria coal field since September 2005. Using the underground mining method, only 10% of the

total coal deposit can be extracted from this field. Whereas, Open-Pit mining or Gasification method might allow extracting around 90% of the total coal deposit. Coal from Jamalganj is not economically viable because of its deep location. A feasibility study for the development of the Dighipara coal field reported that a total of 90 MT could be extracted in 30 years at an annual rate of 3 MT by the Underground Mining Method (UMM) (Bangladesh Economic Review 2022).

Table 1: Coal Fields of Bangladesh

Ser No	Coal Field	Year of Discovery	Depth (Meter)	Estimated Reserve (Million Ton)
1.	BARAPUKURIA	1985	118-509	410
2.	DIGHIPARA	1995	328-455	706
3.	PHULBARI	1997	141-270	572
4.	KHALASPIR	1989	222-516	685
5.	JAMALGONJ	1962	640-1158	5450
			Total	7823

Source: Bangladesh Economic Review 2022

Renewable Energy (RE) At present, according to SERDA, an 1171.29 MW renewable energy system has been installed out of which only 810 MW is On-grid. The government planned to generate 10 % (2000 MW) of the power from renewable sources which stood at 2% in 2021 and at 4.5% in 2023 (SREDA, 2023).

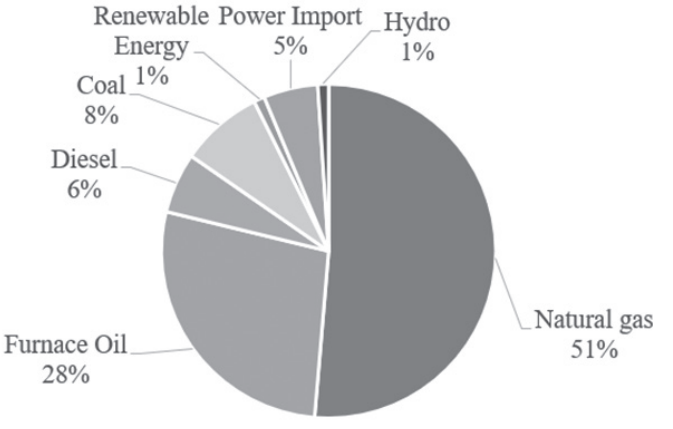
Nuclear Power. To meet the growing demand for electricity in the country, Bangladesh signed a general contract with Russia on December 25, 2015, to construct and commission the country's first nuclear power plant (2X1200 MW) at Rooppur in Pabna at the cost of $12.65 billion (PD, Rooppur NPP).

Table 2: State of Nuclear Energy in Bangladesh

Unit	Type	Capacity	Construction Start	Commercial Operation
Rooppur 1	VVER-1200/V-523	1200MW	October 2017	2024
Rooppur 2	VVER-1200/V-523	1200MW	2018	2025

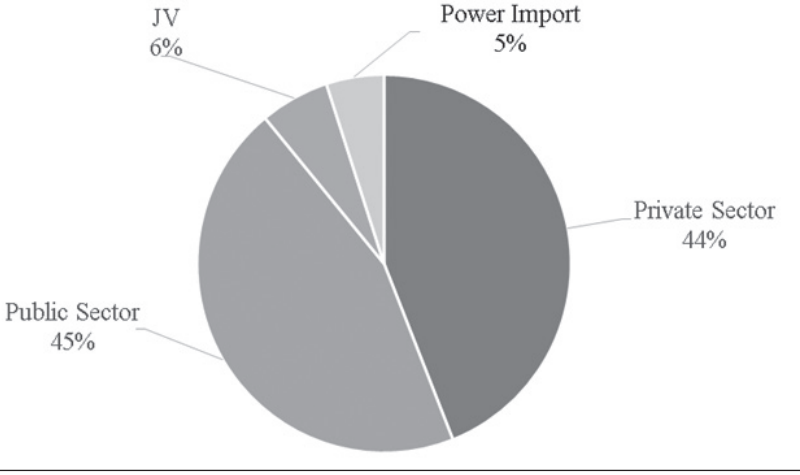
Power Generation Capacity. In FY 2021-22 (up to January 2022), the total grid-based installed capacity was 22,066 MW including 9,996 MW in Public Sector, 1,244 MW in Joint Venture (JV), 9,481 MW in Private Sector and 1,160 MW of power imported from India (BER 2022) (Figure 6 and Figure 7). Considering captive and renewable energy, the total installed off-grid and on-grid capacity of Bangladesh is now 25,284 MW.

Figure 6: Installed On-Grid Capacity - Fuel Type



Source: BER, 2022

Figure 7: Installed On-Grid Capacity - Sector-wise



Source: BER 2022

In FY 2010-11 maximum power generation was 4,890 MW, which was increased to 13,525 MW in FY 2021-22 (Table 3).

Table 3: Installed Capacity and Maximum Power Generation

Fiscal Yr	Installed Capacity MW	Maximum Generation MW	% Generation
2010-11	7264	4890	67.32
2011-12	8716	6066	69.60
2012-13	9151	6434	70.31
4013-14	10416	7356	70.62
2014-15	11534	7817	67.77
2015-16	12365	9036	73.08
2016-17	13555	9479	69.93
2017-18	15953	10958	68.69
2018-19	18961	12893	68.00
2019-20	20383	12738	62.49
2020-21	21395	13792	64.46
2021-22 (Up to Jan 22)	22066	13525	61.29
Source: Power Division, 2022			

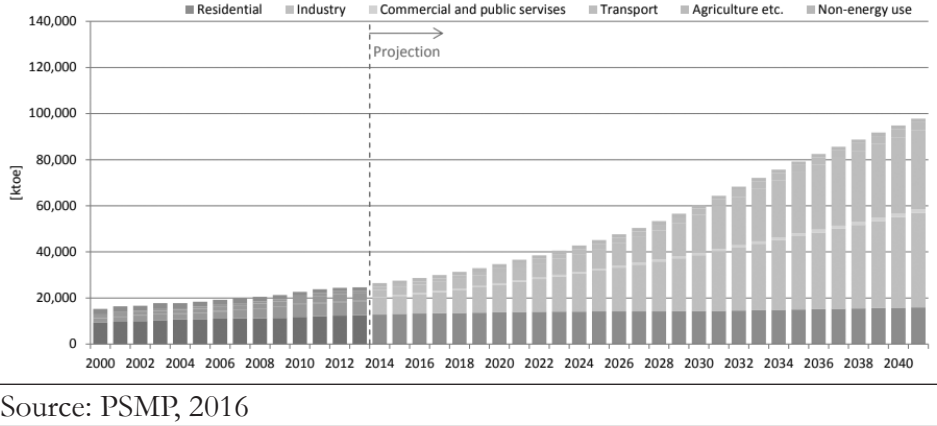
Import of Electricity. Since 09 April 2023, Bangladesh has been importing 1,860 MW of electricity from Baharampur, Tripura and Jharkhand of India. After signing the power purchase agreement with BPDB, Adani Power Limited of India started supplying over 700 MW to the national grid on 09 April 2023 from its first 800-MW ultra-super-critical thermal power generation unit. Bangladesh is expected to receive 800-MW more electricity from Adani Power Limited in June. A joint working group of Bangladesh and Nepal is working to import 500MW of electricity from Nepal. The group will be seating in November at Nepal for the sixth meeting.

Projected Demand, Production and Consumption. Due to the growing population, increasing urbanization and industrialization, the energy demand in Bangladesh has been increasing at a significantly high rate along with GDP growth (Table 4).

Table 4: Projected Power Demand and GDP Growth							
Fiscal Year	2015	2020	2022	2025	2030	2035	2041
Projected GDP Growth Rate	6.3%	7.4%	-	7.4%	6.3%	5.3%	4.4%
Projected Demand (MW)	12098	16900	-	24147	33800	45014	60836
Actual GDP Growth Rate	6.3%	3.4%	7.2%	-	-	-	-
Projected Demand (MW)	12098	14155	16193	-	-	-	-
Actual Generation (MW)	7817	12738	13525	-	-	-	-
Source: PSMP, 2016 and Bangladesh Economic Review 2022							

With the rapid industrialization in Bangladesh, it is expected that there will be a shift in the industrial sector from labor-intensive industries like RMG to energy-intensive industries. It is estimated that the energy consumption of Bangladesh is likely to increase at a rate of 6.3% every year. According to this scenario, growth in energy consumption will slightly exceed the GDP growth rate (the annual average real GDP growth rate is 6.1%) (PSMP, 2016).

Figure 8: Projection of Final Energy Consumption



Source: PSMP, 2016

Current Demand and Shortfall. According to the Bangladesh Power Development Board (BPDB), the peak demand for electricity in the near past

was approximately 15,500 MW in 2021, while the available supply was around 13,500 MW although the installed capacity was 21,395 MW. This represents a shortfall of about 2,000 MW. As a result, the country has been grappling with frequent power outages and load shedding to manage the demand-supply gap. The requirement for energy is increasing every day with the urge for economic development. So, the gap between capability and requirement increases which needs to be taken care of. More so, the Power Division (2018) reports that the generation capacity of the existing power plants will decrease gradually and expand the gap further.

Major Takeaways

- There is a growing shift worldwide toward renewable energy from fossil fuels.

- Bangladesh is still heavily dependent on fossil fuels including imported fossil fuels like coal, oil and imported LNG and this is likely to dominate the energy mix in the near future.

- Although Bangladesh has a considerable amount of coal reserves but it is extracting a very meager quantity by ongoing underground mining method.

- The decision to explore, the use of indigenous coal for power generation and the method of coal mining needs to be taken at the policy-making level.

- Bangladesh could not attain the targeted 10% renewable energy by 2020, rather could attain only 4.5 % (as of Jun 2023) because of lack of initiative by both public and private sectors.

- Bangladesh needs to review its energy forecast and prepare an attainable renewable energy generation target. Most importantly, within the overall target, further source-wise breakdown (solar, wind, nuclear, etc) needs to be worked out.

KEYNOTE PAPER-2

LIKELY ALTERNATIVE SOURCES OF ENERGY FOR BANGLADESH

Alternative Energy Currently in Use

General. Bangladesh Renewable Energy Policy 2008 set the goal of 10% of total electricity generation from renewable clean sources by 2020. The country has managed to get only 4.5 % of the power from renewable energy sources, including off-grid solar home systems by 2023. Bangladesh expects 40% power generation from renewable energy by 2041 (USAID, March 2021).

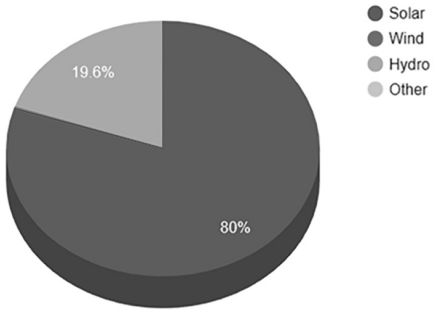
Renewable Energy (RE). According to SREDA, the current RE installed capacity is 1171.29 MW which includes both off grid 360.43 MW and on grid 810.86 MW where Solar is contributing 80%, Hydro more than 19% and other sources like Bio-energy and others less than 1% (Table 1 and Figure 1).

Table 1: Renewable Energy Currently use, 1171 MW in Bangladesh

Technology	Off-grid (MW)	On-grid (MW)	Total (MW)
Solar	357.34	579.96	937.3
Wind	2	0.9	2.9
Hydro	0	230	230
Biogas to Electricity	0.69	0	0.69
Biomass to Electricity	0.4	0	0.4
Total	360.43	810.86	1171.29

Source: SREDA

Figure 1: Renewable Energy Currently in Use



Source: SREDA

Non-Renewable Energy (Nuclear). Bangladesh is implementing Rooppur Nuclear Power Plant (RNPP) project with a capacity of 2400 MW, (1200MW x 2). First unit may start its commercial operation by 2024 and the second unit by 2025. Furthermore, the government plans to increase the generation up to 4,800 MW by 2041.

Solar Energy

Solar Energy - Installed Capacity. In Bangladesh major portion of the renewable energy comes from solar energy. Currently, Bangladesh has an installed capacity of solar energy about 937 MW from Solar Park, Rooftop Solar, Nano-grid/ Micro-grid/Solar Mini, Solar Irrigation, SHS etc (Table 2).

Table 2: Solar Energy - Installed Capacity

Ser	Technology	Quantity	Off-grid MWp	On-grid MWp	Total MWp
1.	Solar Park	10	0	461	461
2.	Rooftop Solar Except NEM	202	18.468	40.892	59.36
3.	Net Metering Rooftop Solar	1880	0	70.084	70.084
4.	Solar Irrigation	2828	49.554	2.162	51.715
5.	Solar Home System	6037689	263.793	0	263.793

6.	Solar Minigrid	28	5.805	0	5.805
7.	Solar Nanogrid	2	0.001	0	0.001
8.	Solar Charging Station	14	0.266	0.016	0.282
9.	Solar Street Light	297691	17.104	0	17.104
10.	Solar Powered Telecom BTS	1933	8.06	0	8.06
11.	Solar Drinking Water System	82	0.095	0	0.095
Total			363.051	574.154	937.204
Source: SREDA					

Solar Energy-Ongoing Projects. Implementation of several projects on solar energy are ongoing with a capacity of 352 MW (Table 3).

Table 3: Ongoing Solar Projects in Bangladesh

Ser	Location	Capacity	RE Technology
1.	Madarganj Upazila, Jamalpur	140.74 MWp	Solar Park
2.	Sirajganj Sadar Upazila, Sirajgonj	88.75 MWp	Solar Park
3.	Sonagazi, Feni	50 MWp	Solar Park
4.	Tetulia, Panchagarh	30 MWp	Solar Park
5.	Dharampasha, Sunamganj	32 MWp	Solar Park
6.	Patgram, Lalmonirhat	5 MWp	Solar Park
7.	Gowainghat, Sylhet	5 MWp	Solar Park
8.	Dhaka City, Dhaka	40 kWp	Solar Roof Top
9.	Dhamrai Upazila, Dhaka	500 kWp	Solar Roof Top
Total		352.03 MWp	
Source: SREDA			

Solar Energy-Potentials. According to a report of UN Chronicle in 2015**,** Bangladesh (within $20^{0}34'$ to $26^{0}38'$ north latitude) has an average of 5 kWh/m^2 of solar radiation falling over 300 days per annum with daily sunlight ranging from 7 to 10 hours. This abundant solar energy has a great potential in various sectors in Bangladesh. According to USAID white paper published in June 2020, total grid-connected Solar Photovoltaic potential in Bangladesh could be as high as 50 GW (USAID, 2020).

In June 2021, Bangladesh cancelled 10 coal-fired power projects. The WB has recommended using the sites of five cancelled coal-fired projects (two in Cox's Bazar's Matarbari, two in Patuakhali, and one in Moheshkhali) amongst those 10 scrapped projects for setting up solar power plants that could produce up to 3,788 MW solar energy. Another solar plant could be built in Jamalpur with a capacity of around 2,518 MW. The six plants could generate 6,306 MW with a set up cost of around $2.46 billion (Staff, 2023). Moreover, unused land of Rampal and Payra Power Plant, large industries of 100 EPZs, floating Solar Power Plants like the one at Chapainawabganj, uncultivable land of CHT and Char lands may be utilized. Incorporation of new energy efficient PV panel will further enhance the solar power production.

Solar Energy-Overall Assessment. Solar Park, SHS and Rooftop Solar Panels needs to be increasingly installed through the Net Metering System. Bangladesh may harness 3,200 MW (+) (937 MW existing, 352 MW Ongoing projects and 2000 MW from scrapped coal plants) solar energy in mid-term (2030) and up to 10,000 MW in Long Term (2041). With proper initiatives and government incentives it is possible to attain 15,000 MW.

Hydro Energy

Current Installed Capacity. Kaptai Hydroelectric Power Station commissioned in 1962 has an installed capacity of 230 MW. In addition, a small-scale micro-hydropower plant of 50 kW was established at Barkal Upazila, Rangamati in 2005 (Monirul Islam Miskat, 2020).

Hydro Energy - Potentials. A 100 MW expansion at the Kaptai hydropower plant by 2041 is scheduled to increase its peak handling capacity (USAID, 2020). BPDB explored two prospective hydropower generating sites at Sangu and Matamuhuri rivers and found potential for about 140 MW and 75 MW, respectively.

Hydro Energy - Overall Assessment. Issues of land scarcity, social and environmental challenges and large-scale resettlement requirement do not make new hydro plant suitable for development (USAID, 2020). Only existing

230 MW and expansion of additional 100 MW from Kaptai hydropower would make 330 MW hydropower energy of Bangladesh.

Wind Energy

Installed Capacity & Ongoing Projects. Currently installed capacity of wind power is only 2.9 MW from Kutubdia Upazila, Cox's Bazar and Sonagazi, Feni. According to SREDA, a 60 MW wind park at Cox's Bazar is expected to connect the grid by the second half of 2023. Another project of 2 MW at Sirajgonj at the bank of the river Jamuna is under implementation and 6 more power plants are under planning (Table 4).

Table 4: Wind Projects Under Planning in Bangladesh

Ser	Location	Capacity
1	Matarbari Maheshkhali Upazila, Cox's Bazar	100 MWp
2	Sonagazi, Feni	30 MWp
3	Mongla Upazila, Bagerhat	55 MWp
4	Cox's Bazar Sadar Upazila, Cox's Bazar	50 MWp
5	Chandpur Sadar, Chandpur	50 MWp
6	Kalapara Upazila, Patuakhali	10 MWp
Total		295 MWp

Source: SREDA

Wind Energy - Potentials. SREDA, BMD and BCAS found wind speed from 4 to 7 m per second above the sea level in some potential sites of coastal area of Bangladesh. Power Division and BPDB have primarily identified 22 potential sites in Chattogram for wind resource Mapping (N.K. Das, 2020). According to a report from NREL, USA with collected data from 2014 - 2017, demonstrated that more than 20,000 km^2 exhibits wind speeds between 5.75 - 7.75 m/s, with wind potential of over 30 GW. (USAID, 2020). Estimation is mostly based on satellite imagery which demands further ground survey. SREDA has set to generate 3,000 MW of wind power by 2030 which will be perhaps difficult to achieve considering the current projects under implementation.

Wind Energy - Overall Assessment. Bangladesh has good potentials in the coastal area and few other places. Implementation of any large wind energy project should be considered based on the success of under implementation Wind Park at Cox's Bazar and Feni. By 2030, 400 (+) MW may be generated from 2.9 MW (existing), 62 MW (Ongoing), 295 MW (Under Planning) & 40 MW from expansion and other sources and 900 (+) MW by 2041.

Bio Energy (Biogas and Biomass)

Current Installed Capacity & Ongoing Projects. Current capacity of bio-energy in Bangladesh is 1.39 MW from 9 projects. IDCOL is implementing a 400 kWp Biogas to Electricity project at Louhajang Upazila, Munshiganj.

Bio Energy-Potentials. Bangladesh has biomass resources such as agriculture residue, rice husk, wood, sugarcane bagasse, municipal waste, and animal waste, etc. Study suggests that the potential of sugarcane bagasse for generating is 178 MW and the rice husk is around 275 MW of electricity (BPDB).

Bio Energy-Overall Assessment. The technical potential of large-scale bio energy is limited in Bangladesh as most of the biomass resources are widely used for other important agricultural and household uses (USAID, 2020). In short term, more state-sponsored or privatized bio-gas plants might be installed in North-West and South-West sectors of Bangladesh to meet localized domestic demand and continue in mid and long term to rest of the part of Bangladesh wherever feasible.

Future Options for Alternative Sources of Energy

Geothermal Energy-Potentials. In 2011, Anglo MGH Energy, a Dhaka-based private company planned the construction of 200 MW geothermal plant, first ever of such kind, in Thakurgaon district but this project never commenced due to lack of feasibility study (Clarion, 2011). The potential of Geothermal Energy in Bangladesh is yet to be explored.

Hydrogen Energy - Potentials. BCSIR has set up a Research Centre and a Pilot Processing Plant for hydrogen-based technologies on January 20, 2021 (Suman, 2021). The potential of drawing hydrogen energy from sea water in Bangladesh is at experimental level and commercialization of such projects is likely to take a long time.

Tidal and Wave Energy- Potentials. In 1984, KUET studied at Cox's Bazar, Maheshkhali and Kutubdia - found average tidal range within 4-5 meter indicating a number of suitable sites (W. Flemming, 2009). Recent study in Dublar Char found tidal potential of 120 MW (S. M. Noman, 2022). However, Tidal and wave energy are new form of energy source and the commercial potential yet to be explored at National level.

Waste to Energy / Electricity- Potentials. An agreement on waste-based power plant was signed on Dec 2021 between BPDB, DNCC and China Machinery Engineering Corporation to produce 42.5 MW of electricity at Aminbazar (UNB, 2021). Narayanganj City Corporation also signed an agreement with Chinese firm U&D on 01 Sep 2022 for 6 MW. BPDB is carrying out a detailed feasibility study for a waste-to-energy power plant with support of Dutch company named GIZ project at Nawabganj. Based on results from Dhaka and Narayangonj pilot projects, waste to energy plant may be installed in rest of the city corporations by mid-term (target 75MW) and in long term 100MW. These projects are focused on waste management rather than electricity production.

Nuclear Energy- Small Modular Reactors (SMRs). As a growing technology, the leading developing countries are presently working towards making Small Modular Reactors (SMRs) with a capacity of 300 MW - 540 MW. It is prefabricated, cost effective and requires less construction time. Refueling requirement is between 3-7 years (conventional plants 1-2 years). Some SMRs are designed to operate for up to 30 years without refueling. More than 70 commercial SMR designs being developed or in the licensing stage in Argentina, Canada, China, Russia, South Korea and the USA. Bangladesh can also consider installation of 4-5 SMRs after 2030. Bangladesh may consider establishment of one SMR by 2030 and 4-5 by 2041.

Cross Border Power and Energy. Bangladesh, Bhutan, India and Nepal (BBIN) Cooperation in the region is known to have variety of sources of energy, which offer complementary energy to each other. Annex A shows the potentials of BBIN Cooperation. Nepal and Bhutan have abundant hydro power potentials, which can be shared with Bangladesh as energy cooperation. Similarly, Myanmar has also 104 GW untapped hydro power potentials which might open another option for regional cooperation with Bangladesh in future.

Major Takeaways

- Solar Energy will be generated 3200 MW (+) by 2030 and 10,000 MW by 2041 including rooftops and SHS.
- Potential of Hydro power in Bangladesh may rise up to 330 MW in mid-term and is likely to remain same in the long term.
- Success of Wind Parks in Cox's Bazar (60 MW) and Feni (2 MW) will pave the way for future. 400 (+) MW may be generated by 2030 and 900 (+) MW by 2041.
- In short term, bio-gas plants might be installed in North-West and South-West sectors of Bangladesh to meet localized domestic demand and continue in mid and long term to rest of the part of Bangladesh where ever feasible.
- By mid-term, waste to energy plant may be installed in rest of the city corporations (target 75MW) and in long term 100MW.
- Potential of Geothermal, Hydrogen Energy, Tidal and Wave Energy remain to be a distant possibility.
- Establishment of one SMR by 2030 and 4-5 by 2041.
- As a whole, by 2030 renewable energy may account for 4,000 (+) MW which is nearly 13% of total expected power generation of 31,120 MW. Similarly, it may rise up to approx. 10000 MW to 12000 MW which accounts for 21% of total expected 56,000 (+) MW generation by 2041.

KEYNOTE PAPER-3
CHALLENGES OF DEVELOPING ALTERNATIVE ENERGY IN BANGLADESH

General. The depletion of gas reserves, and frequent price hikes in energy have not only exerted extreme pressure on current power production, but also pose a threat to energy security. There are lots of challenges for the industry to secure a stable supply of energy and ensure energy security for the entire population. Bangladesh is also committed to shift towards alternative energy but it has enormous challenges too.

Challenges to Overall Energy Sector

Limited Generation Capacity. Bangladesh's current installed power generation capacity is around 25.28 GW, which is not sufficient to meet the growing demand for electricity. However, the full capacity of power generation could not be materialized historically. Leaving 20% capacity for maintenance and forced outage, the available generation capacity should be about 19440 MW without fuel constraint. However, the maximum generation actually obtained on 13 Apr 2023 was 15,304 MW, which was much lesser than 19440 MW.

Dependency on Natural Gas. Natural Gas is the major source of energy for domestic use and power generation in Bangladesh accounting 51% of our energy share. According to Petro Bangla, the daily gas demand is 3,126 mmcfd while the supply stands at 2284 mmcfd keeping a daily shortage of approx. 1000 mmcfd (Prothom Alo, 2023). The current deficiency cannot be fully met by import, as the LNG import capacity is limited due to shortage of storage facility (max 900 mmcfd). Bangladesh needs to increase storage capacity of imported LNG.

Dependency on Imported Coal as a Primary Fuel. At present Coal contributes in 8% of total power generation of which 7% comes from imported coal. The government envisioned generating 30% of electricity from coal-based power plants by 2030 (BPDB, 2016). The challenge with respect to

indigenous coal is still being debated. Policymakers at government level had not been able to come to a consensus regarding the method of exploration of domestic coal resulting in dependency on import.

Capacity Payment of Quick Rental (QR) Plants. At present, 20 QR Plants are in operation with a generation capacity of 1745 MW (Amin, 2019). Contracts for most QR plants were awarded based on unsolicited offers under the 'Speedy Supply of Power and Energy Act-2010' with a provision of immunity to those involved with quick-fix remedies. According to the media report, BPDB paid Tk.6000 crore extra as Capacity Charge to the QRs during the original contract period (2009-2014) and another Tk 2000 crore after the extension of 15 QRs (2014-2017). Despite significant underutilization of grid capacity, it is not relevant for extending the timeline of QRs. Most of these QRs are HFO and a few HSD based resulting in the petroleum import burden for the government. Over the years, this capacity payment has become a huge burden for the government and remained a source of serious controversy and lack of transparency. The government paid a total of Tk 35,046 crore in capacity payments to IPPs owned by 55 companies during the July 2019-March 2022 period.

Dependency on Single Country Grid for Cross-Border Power Trade. The existing regional electricity trade agreements are bilateral in nature. Bangladesh is importing power from India only. Bangladesh government can import hydropower electricity from Nepal and Bhutan (Ministry of Finance, 2022). However, electricity from Nepal and Bhutan will also have to be transmitted through India. Bangladesh has discussed financing Bhutan's hydropower and importing 340MW of electricity through India (Bangla Tribune, 2023).

Obligation to International Commitment. Bangladesh is committed to unconditional reduction of Green House Gas (GHG) emissions by 6.73% and an additional conditional reduction of 15.1% by 2030, subject to appropriate international funding. The government has also targeted reduction of CO2 emission and temperature rise by 2 degrees Celsius. As such, Bangladesh needs to give adequate importance in renewable energy.

Challenges to Alternative Energy Sector

Policy Barriers

Lack of Policy Implementation. Lack of single comprehensive policy and financial support from the government are the main challenges for the renewable energy sector to take off in Bangladesh. However whatever policies it has, the main problem begins during its implementation. Current policy is that renewable energy projects can only be sited on non-agricultural land (USAID, 2020) but there is no clear government definition of what is considered non-agricultural land. According to BNBC 2020, all high-rise buildings should be designed with rooftop solar panel but there is no implementation on ground. Initially, for renewable energy to take off requires heavy government patronage.

Fossil-based Energy Monopoly. Lion's share of the energy market in the country is under fossil fuel. This over dependency on fossil fuel sources is an obstacle towards the growth of alternative sources. Solar, wind and other renewable sources of energy have to rival with the well-established fossil fuel industry. As such, most of the private investment has taken place in fossil-based power plants.

Institutional Barrier

Lack of Governmental Support. The 8th FYP set a target of achieving 10% renewable share by 2020 where the current renewable share is only 4.5% including off-grid production. However, FY 2022-23 budget has not given due importance towards renewable energy. Among 66 projects in ADP for FY2022-23 under the Power and Energy Sector, only 5 projects are RE based (4 generation and 1 distribution based).

Lack of Institutional Capacity. Progress in the renewable energy sector in Bangladesh has slowed due to a lack of institutional capacity within public and private organizations and lack of coordination between government institutions. Moreover, due to lack of experience of BPDB in regards to power purchase from renewable energy, IPPs has led to issues in negotiating terms and tariffs. Therefore, many renewable energy projects already approved in Bangladesh have not moved forward with implementation.

Geographical and Environmental Barrier. The scope of massive expansion of onshore wind is limited in Bangladesh. Potential and economically viable power generation from wind requires wind speed of 5.75 m/s and above (Hasan, et al., 2019). However, this amount of speed is only available in few zones of the country. Wind speed is not also constant all the time. Solar system requires quite a large area and are unable to work at night and during rainy season (Hasan, et al., 2019). High initial investment and complete foreign dependency on Nuclear Fuel (Uranium) is required to develop Nuclear Energy. Hydro potential, especially which is based on elevation, is limited in the country (Hossain and Chisti, 2022).

Economic Barriers

High Implementation Cost of Renewable Energy Projects. Solar, wind and hydro power systems require expensive equipment and infrastructure, which may still not be affordable for a large portion of the population. Increase in imported tariff in the budget of FY 2022-23 would significantly raise the cost of imported renewable energy equipment (Moazzem, 2022). It would further increase the implementation cost and slow down the use of renewable energy in Bangladesh.

Lack of Financing in Renewable Energy Projects. Due to a lack of experience in renewable energy project financing and not understanding the associated risks involved as well as long-term return, commercial banks in Bangladesh are wary of investing in renewable energy projects. As such, they generally offer unfavourable loan terms and high interest rates (USAID, 2020).

Lack of Incentives to the Private Sector. Large-scale investment in renewable energy by government has not yet been observed in the country. Efforts by IDCOL are welcome albeit small scale. Reducing financial costs could also offset the high cost of procuring land for projects (SREDA, 2015, p. 56). Again, incentives offered for conventional power plants do not always apply to renewable energy projects. For example: private power companies for conventional power plants are exempted from corporate income tax for a period of 15 years, whereas renewable energy plants are exempted only for a period of five years (USAID, 2020).

Awareness Barrier

Lack of Awareness. Industries, public organizations, policy makers, and financial institutions are not aware enough of diverse renewable energy technology development opportunities. As such, lack of awareness and application of green building policies and slow technological adoption continue to remain as a challenge for Renewable Energy in Bangladesh.

Lack of Energy Efficient Appliances. Despite the government's efforts, one of the major issues towards attaining energy efficiency is, public's lack of knowledge and education regarding energy-efficient methods.

Need for Demand Shifting. Solar power can be produced only at daytime. The peak demand in our country is usually during evening when solar panels remain inactive. To ensure proper utilization of solar energy there is a need to bring a shift in our demand pattern by changing life style. Country like Japan is a very good example that has shown efficiency in using the solar energy by demand shifting.

Technical Barrier

Inefficient Transmission Line. The present transmission infrastructure is mainly built for fossil fuel plants. Most electric transmission and distribution lines were constructed during the 1950s and 1960s. Those have passed their 50-year life expectancy, thus making them incompetent to meet the demand of the hour and severe climatic changes.

Lack of Power Storage System. Essential technologies such as battery storage systems allow energy from renewables, like solar and wind, to be stored and released when power needed after sunset. Bangladesh doesn't have these technologies yet. The storage problem is a major challenge worldwide and Bangladesh is no exception to that.

Infrastructural Barrier

Land Scarcity. One of the key challenges is the land scarcity for constructing the necessary infrastructure for renewable energy. The proportion of agricultural land in Bangladesh decreased from 91.83% in 1976 to 70.63% in 2016 (USAID, 2020). The current policy is that renewable energy projects can only be sited on non-agricultural land. Large utility-scale wind projects require an area of between 0.5 to 1.3 acres of land per MW and solar power plants require about 3 to 4 acres of land per MW of power generation (USAID, 2020).

Un-suitable Grid Capacity and Stability. Renewable energy components are not yet synchronized with the future electricity transmission infrastructure plans. As most of the future solar and wind projects are expected to be located far from the national grid, the current capacity of the transmission network will only be able to accommodate smaller renewable energy projects. Previous experience has shown that, for renewable energy projects, developers are expected to take responsibility for grid connection infrastructure. This is certainly a challenge to obtain clearance certificate from PGCB for such construction. This also burdens the investors to attain the right way for the connecting transmission line that is a challenging job even under favorable condition. Depending on the distance, the cost of constructing the line may double the project cost.

Human Resources Capacity Barrier. Transition from use of traditional fossil fuels to greater use of renewable energy is considered extremely important in increasing energy supplies. However, lack of skill development tends to hamper this transition due to the fact that, skilled workforce that can install, maintain and operate renewable energy infrastructure is unavailable in Bangladesh. Most of the existing technologies come from abroad and investment in the technical capacity of local engineers and technicians is insufficient to replicate them economically.

KEYNOTE PAPER-4
SUGGESTIVE MEASURES FOR THE LONG TERM DEVELOPMENT OF ENERGY SECTOR IN BANGLADESH

General. For transition to a green and decarbonized energy mix, Bangladesh needs ambitious goals and smart strategies to attain Vision 2041. Although IEPMP makes some affirmative assertions, yet that is far from 40% clean energy by 2041.

Annex 8C: Year-wise Fuel Based Generation Capacity up to 2041 as per PSMP-2016 Base Case

	2020	2021	2025	2030	2035	2041
Fuel-wise composition (MW)						
Gas/LNG	9,928	9,562	8,515	8,731	14,746	19,477
Coal	5,873	5,873	6,977	9,377	11,777	20,195
Oil	3,900	3,705	4,005	4,250	2,373	700
Hydro	230	230	230	330	330	330
Nuclear	-	-	2,232	3,432	4,632	7,032
Cross Border	1,200	2,000	2,500	5,000	7,000	9,000
Total	**21,130**	**21,369**	**24,459**	**31,120**	**40,858**	**56,734**
Fuel-wise composition (%)						
Gas/LNG	47%	45%	35%	28%	36%	35%
Coal	28%	27%	29%	30%	29%	35%
Oil	18%	17%	16%	14%	6%	1%
Hydro	1%	1%	1%	1%	1%	1%
Nuclear	0%	0%	9%	11%	11%	12%
Cross Border	6%	9%	10%	16%	17%	16%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

72 71

Looking at the perspective plan, it seems fossil fuel will be generating more than 70% of the electricity and RE is not even close to 10% let alone 40%. As a whole, it leaves many questions and lots to be done to achieve it and revisiting the forecasted energy demand, energy mix (as mentioned in Perspective Plan of Bangladesh, 2021-2041 by Planning Ministry) by 2030 and '41 would be necessary to make the energy master plan an attainable, affordable and most importantly a sustainable one. Energy from hydrogen, tidal, wave etc. are still unproven and perhaps, not suitable for Bangladesh in the near future. From the previous chapters, it is evident that energy generation to meet 2041's need will have many challenges to bring greener energy and replacing the fossil fuel would be difficult.

Serial	Challenges Identified	Ways Forward
1.	Limited Generation Capacity	Increase generation with new energy mix (increase RE Share and decrease fossil fuel)
2.	Dependency on Natural Gas	
3.	Dependency on Imported Coal as a Primary Fuel	
4.	Capacity Payment of Quick Rental (QR) Plants	• Review policy framework • Incentivize and promote RE • Reduce Fossil Fuel • Diverse Cross Border Power Trade • Patronize RE • Privatization, PPP
5.	Policy Barriers	
6.	Dependency on Single Country Grid for Cross-Border Power Trade	
7.	Institutional Barrier	
8.	Environmental Barrier	
	Economic Issues	
9.	Awareness Barrier	• Awareness program • Sensitization • Reward and Punishment
10.	Technical Barrier	• Capacity building • Infrastructure development
11.	Infrastructural Barrier	

As seen in the table, each challenge do not have a standalone remedy due to the fact that generation, transmission, distribution are interdependent and intertwined with other challenges. For example, change in energy mix by increasing one type of energy, say solar, collaterally affects others energy - its origin, whether domestic or imported, geographic location, financial involvement and cost benefit of the energy generation. As such, the suggestive measures to achieve energy security in succeeding paragraphs will follow an itemized approach. In doing so, immediate or short-term is referred as 2025, mid-term by 2030, and long term by 2041.

Overhaul Generation, Transmission and Distribution. Mid-aged power plant's turbines, boilers, capacitors might be overhauled to increase their production by 15-20%. The same should be done with transmission lines and power sub-stations. Modernization, rehabilitation and expansion of existing power plants and Grid System, and phasing out inefficient or age old power

plants with poor plant factors, both public and private, with new energy efficient power plants should be done by mid-term. Periodic inspection of privatized power plant should be in place and non-functional/ inefficient power plants are to be penalized as per agreement. By long term, energy efficient power plants, both public and private, should be built adopting large scale and low-cost fuel option.

Private - Public Power Plants' Apportionment and Power Generation Dynamics. Private power plants, which were a dire need in 2010, have contributed the power and energy sector positively yet the financial cost was heavy (Kallol Mostafa, 2023). In last April, the day Bangladesh had record 15,234 MW production of electricity against 22,066 MW capacity (more than 30% kept as capacity) which seems over assurance of capacity building, yet that very day, Bangladesh experience load shedding. 44% privatized power generation in Bangladesh could not yield the desired outcome due to wide range of corruption, unaccountability and manipulation. Over estimation of demand and its consequential capacity charge have syphoned substantial amount of money and burdened GDP of Bangladesh. As such, estimation of future demand should be revisited carefully and, thereafter, new power plants should be planned to meet the future demand. In doing so, privatized power plants might be increased to 50% in mid-term and 60% in long term. Public- Private-Partnership (PPP) would be a good option to make balance between public and private power generation dynamics. Privatization focus should be shifted to RE from fossil fuel immediately and continue to long term through mid-term.

Dependency on Coal Power Plant. Decision to install new coal based power plants should be carefully evaluated in the context of environment and national interest. Since this offers the cheapest power generation, Bangladesh needs to use limited number of coal plants to meet its overall demand. Although Energy Master Plan envisaged coal based power generation amounting 30% by mid-term and 35% in long term, it would be better to gradually decrease the percentage to 22% in mid-term and 20% in long term considering RE will generate the balance of the power generation. Using domestic coal in coal power plants might be planned by mid-term as pilot project. Basing on its success, in long term, coal plants using domestic coal might be installed.

Regional Cooperation. Once transmission lines will be completed between Nepal, Bhutan and Bangladesh through India, BBIN cross border energy sharing may be increased to 17% in mid-term (forecasted 16%) and in long term 20% (forecasted 16%). Import from allied nations may only be an option provided the imported energy is cheaper and cost effective for Bangladesh's economy. Untapped energy of Myanmar might be considered in mid and long term for cross border electricity or natural gas trade**.** Myanmar has almost 104 GW of hydroelectricity potentials out of which it only uses 3%. This will allow Bangladesh to reduce dependency on grid of single country. While importing power, dependency upon one source/ country should be kept less than 10%. As such, in long term, the energy import might be 8% from India, 5% from Nepal-Bhutan and 7% from Myanmar respectively.

Renewable Energy

Solar Enegry. Use of Monocrystalline, transparent Photovoltaic films, Polycrystalline and Thin-film solar panels of present technologies have field efficiency up to 22% should be promoted. Similarly, Bangladesh should promote micro, mini, nano-grids with Net-metering in rural areas for domestic use, irrigation and micro and small enterprises. In short term and mid-term, state sponsored or privatized solar plants are to be installed in feasible areas with modern PV panels. All feasible lands need to be utilized for developing Solar Parks. Additionally, large factories in all 100 EPZs, roofs of schools and colleges can be utilized for Solar Power generation. In this approach it will be possible to generate approximately 3200 MW by 2030 and 10,000 MW electricity by 2041.

Wind. Immediately, the projects in Feni and Cox's Bazar are to be completed and based on the outcome, more wind mills should be planned in coastal areas by mid and long term. Target is to generate 400MW by 2030 and 1450MW by 2041 from wind energy.

Energy from Waste. Results from Dhaka and Narayangonj pilot projects should be studied, thereafter, install such power plants to rest of the city corporations by mid-term (target 75MW) since all the city corporations have

waste collection and disposing system in place; and finally, in long term, the similar power plants might be established to all municipalities across the country (target 100MW).

Hydro-electricity. Increase power generation capacity of Kaptai Hydro-electricity plant by100MW to 330MW by mid-term and continue the same in long term.

Bio-Gas. In short term, more state-sponsored or privatized bio-gas plants might be implemented in North-West and South-West sectors of Bangladesh to meet localized domestic demand. This should continue in mid and long term to rest of the part of Bangladesh wherever feasible.

Nuclear Energy. Taking lessons from Rooppur, some other advanced countries like USA, France, Japan, South Korea might be brought in to set up other plants in Lebukhali, where areas are earmarked for two more plants, in long term to avoid being monopolized in future by Russians as regards to technology, skilled labour, fuel etc. After 2024, possibility of new Small Modular Reactors (SMRs) is expected to pave the way of getting more nuclear energy for Bangladesh. This would be almost 5-6 times cheaper to install, requires one tenth of area, requires only 2 years to set up the plant - would probably be affordable and sustainable energy option globally in days to come. As such, one SMR of 540MW in mid-term and four more SMR in long term might be planned to increase the nuclear powered generation by 2041.

Capacity Building and Exploration of Gas Fields. Local stakeholders of energy sector, mainly energy companies like BAPEX, Bangladesh Gas Field Company Ltd (BGFCL), Sylhet Gas Field Ltd (SGFL) etc. should be improved by providing financial and other technical as well as non-technical supports immediately and that should continue in mid and long term. Capacity building of BAPEX for gas exploration should be made our top priority to explore inland gas blocks of Bangladesh by mid-term; capability to explore offshore blocks should be attained by long term. Few offshore gas blocks must be explored by mid- term by international gas/oil exploration companies and the rest should be by BAPEX in long term.

Developing LNG and Its Associated Infrastructure. Unless new gas fields are discovered and added to national grid, dependency on LNG import will soar in near future and it's going to last in long term as well. As such, Shore or Land Based Storage Regasification Unit should be installed to maintain 24/7 gas flow irrespective of weather condition.

Long Term Energy Deals and Energy Source Diversification. Considering the dependency over LNG, long term energy deals to be done with LNG exporting nations like Quatar, Australia, Malaysia, Nigeria to ensure Bangladesh's base load is secured. Otherwise, huge forex will be used to buy LNG from spot market in any Ukraine- Russia like scenario which may destabilize the energy security of Bangladesh. Moreover, Bangladesh needs to diversify its energy source and reduce dependency on single source such as Middle Eastern countries and explore the opportunities of importing energy from Africa.

Policy Frame Work and Integrated Regulatory Body. Quick Rental and Special Provision Act 2010 should be reviewed and scrapped. On the contrary, to jump start renewable energy, zero tariff on imports related to renewable energy, tax incentives to both renewable energy providers and users should be introduced forthwith. To efficiently manage the energy sector, Energy Regulatory Commission should be empowered more to control, coordinate and synchronize generations of all public-private power plant, transmission and distribution. Similarly, national policy related to use of Coal should be formulated forthwith

Transparency and Accountability. All agreements and contracts between G2G, between GoB and local /international private partners should be made transparent, accountable and most importantly national interest should be upheld at all cost. Non-government subject matter experts, Parliamentary Standing Committee for Energy, Energy Regulatory Commission etc. should bring out detail analysis of any forthcoming agreement. Any deal struck which is detrimental to national interest should be brought to justice.

Hybrid Grid, Smart Grid and Net-Metering. Net-metering and Smart grid should be incorporated in Dhaka City Corporation in short term; by mid-term

to all city corporations and by long term in all district's major cities. Hybrid Grid should be incorporated in islands, coastal areas, hill tracts, where national grid is not available, by mid-term and this will continue to long term until those are connected to national grid.

Demand Management, Energy Efficiency and Energy Conservation. Demand should be calculated based on Demand Curve which is different in BD than developed countries. Day's peak hour can be manipulated by staggering weekly holidays, school and office working time - which will benefit renewable energy integration and use of it during day time. Welding, irrigation between 2300 hours to 0800 hours using national grid etc. will assist demand shift and alter peak hour indeed. Massive sensitization and awareness program are to be conducted to encourage use of energy efficient equipment and reduce wasting of energy. Energy pricing should be market based and may follow a sliding scale/ slab while distributing for domestic use. Tax incentive, cash back on SHS, micro and nano-grid may be introduced immediately. Similarly, in long term, progressive punitive measures may also be implemented (such as monitory penalty, imposing higher tax etc.) to those who are not using solar energy properly or wasting it.

Conclusion

Bangladesh's energy sector is at a cross road; it needs tremendous rise in power generation to cope with its economic growth. The overall scenario is further perplexed by post-COVID recession, price hike of fossil fuel emanating from Russia-Ukraine war and inflation caused by both. Although the country has excelled immensely well in power generation by quick rental and private investment, yet this came at serious cost to the economy. There are enormous opportunities in renewable and green energy in the world today and most of the western and modern countries are moving to that direction very rapidly, even our closest neighbour, yet Bangladesh has to do a lot in mid and long term.

The geographical location of Bangladesh, its population density, heavy demand of energy for its industries as well as huge domestic demand make it a great

challenge for a complete green transformation. However, over the period of time, dependency on fossil fuel has to be reduced substantially. Alternative and renewable greener energy mix to be implemented over mid and long term period. In doing so, wind, solar, nuclear would suit Bangladesh better while natural gas and coal, both local and imported, with varied proportion needs to remain as major part in the energy mix.

Recommendations

- Solar energy is the most potential alternative energy source for Bangladesh. Ongoing efforts such as SHS, Solar irrigation, Rooftop Solar Panel, Solar micro/Mini Grid should be encouraged. Government may introduce incentive measures encourage both consumers and producers to move towards Solar power. Target of increasing SHS from 6 million to 10 million by 2030 may be set. Steps are recommended to be taken to convert .3 million out of 1.6 million irrigation pumps into solar pumps by 2030 and another .5 million by 2041. Establishing rooftop solar system may be made compulsory for schools, colleges and office complexes by 2030. Efforts may to be taken to establish rooftop solar system at least in 5 large industrial complex of all 100 EPZ each by 2030 and another 5 each by 2041.

- In the mid-term, government may establish large scale Solar parks in the sites of 5 abandoned Coal power plants and in the proposed sites of Jamalpur. This is likely to generate around 3200 MW of low cost power by 2030. By 2041, spaces of remaining 5 abandoned coal power plants, leftover space of Pyra and Rampal power plants, uncultivable spaces of CHT and Char areas of plain lands are to be used for establishing solar parks for producing around 10,000 - 12,000 MW of Solar Power.

- Even though started in 2018 in Bangladesh, yet the focus towards Net Metering is very low. Commencing from 2024, government may take initiative to introduce Net Metering systems across all the households, industries, Schools, Colleges, Office complexes having solar system and ensure completion of adoption of the technology by 2030.

- Without leaving it unutilized, a decision about the usage of precious domestic coal must be made at the policy-making level without further ado. Bangladesh is yet to finalize its Coal Policy. Cost benefit analysis, discussion, public opinion generation, undertaking pilot project to examine open pit technique feasibility at North Boropukuria, etc. needs to be undertaken to finalize the decision without making any further delay.

- Low cost cross border power import may be increased up to total 18% by 2041. Bangladesh may diversify its power import from India, Nepal, Bhutan and Myanmar. By 2041, Bangladesh may import 7% (around 4000 MW) power from India, 5% (around 3000 MW) power from Nepal and Bhutan. Considering the huge potentials, it is recommended to import around 6-7% cross border power (around 3500 MW) from Myamnmar by 2041. Importing energy from Myanmar will enhance flexibility, enable importing power at competitive cost and this economic relation with Myanmar may act as leverage to solve other issues as well.

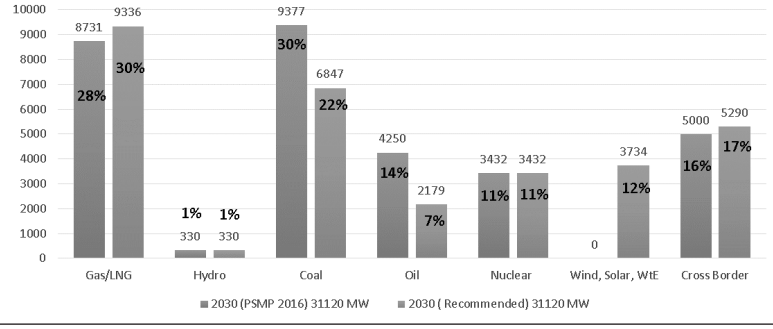
- Basing on the experience of Rooppur Nuclear Power Plant, by 2041 Bangladesh may establish 5 Small Modular Reactors of 540 MW capacity each. This will need small area, less time to establish, comparative low cost to conventional nuclear plants and affordable energy source.

- Changing the energy mix (Details at Annex A)

    - In the mid-term (2030) Bangladesh needs to reduce dependency on Oil from 14% to 7% and Coal from 30% to 23 % and enhance the contribution of Solar, Wind and Waste to energy from 4.5% to 14 %

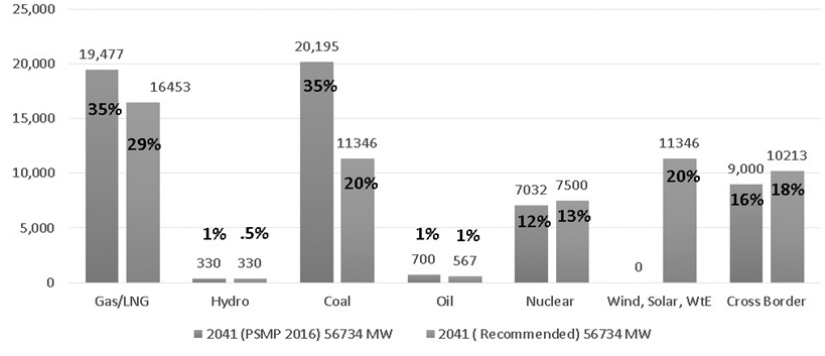
    - In the long term (2041) Bangladesh needs to reduce the oil dependency to 1%, Coal to 20%, increase contribution of renewable to 20% and cross border to 18%.

Figure 1: Recommended Energy Mix for 2030



Source: PSMP 2016 and author's Analysis

Figure 2: Recommended Energy Mix for 2041



Source: PSMP 2016 and author's analysis

- QR plants have lost their relevance and have become white elephants. Efforts are to be taken immediately to gradually retire the QR plants and engaging in new contract with private sector in the form of Public Private Partnership for large scale low fuel cost power plants maintaining transparency and accountability.

- Efforts for on-shore and off-shore gas exploration needs to be taken immediately. In the short term, IOCs may be involved for gas exploration. For the long run, capability of BAPEX need to be enhanced that would allow independent gas exploration by the national company.

- Steps to be undertaken to introduce Smart Grid System in all City Corporations in the mid-term (by the year 2030). This will allow the user

greater control over own energy use and costs and enable to provide more reliable power.

- Considering future dependency on LNG, off shore and on shore LNG storage capacity of 3000 mmcf by 2030 and 5000 mmcf by 2041 may be developed. A phased approach may be undertaken involving private sector to realize this. The concept of Public-Private Partnership may be employed to draw investment here.

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ANNEX A

CROSS BORDER POWER AND ENERGY TRADE

Cross Border Power and Energy Trade - Prospects of Bangladesh-Bhutan-India- Nepal (BBIN) Cooperation

Together, Bangladesh, Bhutan, India and Nepal (BBIN) are home to 20.54 % (2021 estimates, World Bank, 2023) of the world's population. This BBIN region has a large number of people living in poverty, which affects their access to energy. Lack of access to affordable and reliable energy sources can hinder economic growth and social development. Further, the growth in urbanisation and industrialisation is predicted to only increase the demand for energy. Despite having a wealth of clean energy resources (hydropower, natural gas, etc.), the area still relies heavily on fossil fuels to meet its energy needs, which also include electricity. Amongst the energy strengths, Nepal and Bhutan have abundant hydropower potential, which is presently under-utilised ((Alam et al., 2017); (Lean, 2014)); eastern India has an abundance of coal (India Ministry of Coal, 2018); and Bangladesh has natural gas reserves (Ministry of Power Energy and Mineral Resources Bangladesh, 2019), although known to last only for a decade or so.

It is evident that there is significant variation in the energy reserves providing adequate opportunities for energy sharing with the BBIN for greater prosperity. As is evident Nepal and Bhutan can export hydropower to Bangladesh and India for their economic growth.

Additionally, this sub-region has abundant access to renewable energy resources like solar, wind, and biomass, which help to meet a significant portion of the region's demand for household energy (Shukla, Sudhakar and Baredar, 2017). Due to their landlocked location and lack of major fossil fuel production and reserves, Nepal and Bhutan are entirely dependent on India for their fuel needs. Within this sub-region, there are significant opportunities for both power trading and the supply of fossil fuels due to the nature of the resources that are accessible, the seasonality of electricity consumption and hydropower production, the closeness of the two regions, and the willingness

of the sub-regional political regime. However, the BBIN region is vulnerable to energy security challenges due to factors such as geopolitical tensions, natural disasters, and dependence on imported fossil fuels. Developing regional energy cooperation and trade could help improve energy security in the region.

Bangladesh has a very good prospect to use alternative sources of energy through cross border power trade in the BBIN. The different pattern of energy sources and requirement including peak timing will facilitate the options under the MoU signed in 2010 for energy cooperation under SAARC Framework. Bangladesh has been receiving 1160 MW electricity from India and MoU with Nepal is almost finalized to receive 500 MW Hydro electricity from Nepal from 2031. The nature and time for demand of power in these countries are found quite complementary to each other's requirement.

Bangladesh may explore the energy sources of its neighbouring countries and import energy from these countries through cross border power trade to meet up the growing demand of the energy. It is found that when Bangladesh is in the peak of the requirements of electricity, Nepal and Bhutan are in a state with surplus electricity capacity.

There is adequate data exists regarding bilateral arrangement between India-Nepal, India- Bhutan and India-Bangladesh for trade of energy. But it will require greater cooperation at the regional level, since there is mismatch between demand and supply in individual countries, both inter- and intra-annually.

Key Drivers for Cross Border Energy Cooperation. Some of the key drivers for cross border energy cooperation in BBIN are:

- BBIN countries have significant population in rural areas, there is a greater requirement for their governments to provide access to electricity to its rural population.

- Need to reduce the power shortfall/ deficit for economic growth, particularly during certain seasonal conditions.

- Reduce dependency on fossil fuel and migrate to net zero carbon in future.
- Effective use of seasonal complementaries for energy management.
- Tap the un-utilised hydropower potential, which is approx over 50,000 MW in Nepal and north east India both, and approx 20,000MW in Bhutan.

BBIN Challenges and Way Forward. Notwithstanding the tremendous potential, there have been roadblocks in harnessing this energy potential. Some of the challenges inhibiting progress in this sector are discussed in the succeeding paragraphs.

Political Challenges

- Reluctance of small countries due to their national security concern is considered to be one of the major political challenges (Pal, 2016).
- Political backlash owing to issues of tariff fixation of power ('Energy Cooperation in the BBIN Region | Welcome to CUTS CITEE', 2019).
- Political insensitivities, domestic politics and inability to arrive at long term consensus on prospects of energy trade in the region.

Policy Challenges

- Lack of harmony in policies and regulations across the border is a notable policy challenge in realization of the integrated power grid in this sub-region (Gyanwali et al., 2021).
- Complexities to develop a competitive market across BBIN for energy trade.

Infrastructure/ Technical Constraints

- Limited cross-border transmission infrastructure; significant transmission losses and distribution, and absence of grid code.
- Absence of comprehensive studies which would elucidate the technical aspects of materialization of energy/ power projects.

Financial Constraints / Investment Challenges

- Poor financial condition of state owned power and energy sector, absence of privatatisation and investment by foreign investors.
- Lack of incentives for investment stemming from absence of clear policy for the region in this sector by respective governments.

Recommendations for BBIN Co-operation

- Undertake the quantitative research on economic, technical as well as environmental benefits of increased sub-regional co-operation (Pal, 2016).
- Political and domestic alignment to the necessity for BBIN energy cooperation.
- Four nations put definitive policy framework agreement for energy cooperation.
- Cross border steering committee is instituted for multi-lateral dialogue to focus on ascertaining 'what' and 'how' to implement energy trade.
- National policies aligned towards cross border trade. Governments to create suitable ecosystem viz create suitable Acts, Regulations etc. in supporting electricity trade, creating preferential approach for BBIN trade, setting multi- discipline empowered body to resolve technical issues ('Energy Cooperation in the BBIN Region | Welcome to CUTS CITEE', 2019).

- Undertake rigorous quantitative assessment in line with the Paris agreement with detailed consideration of the spatial distribution of indigenous resources, the hourly variations of electricity demand and output from intermittent renewables across the region, the seasonal variations of hydropower, the grid topology, the coal transportation linkages, the carbon capture and storage technology (Gyanwali et al., 2021, p. 24).

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QUESTION AND ANSWER SESSION
(Summarised by the Rapporteurs)

A lively interactive session held in the later part of the seminar. During this session, several issues were raised which are summarized as follows:

Question-1. Do you think the government should remove huge burden of the subsidies on electricity in Bangladesh in order to ease the fund crisis?

Answer: The concern stemmed from the substantial burden these subsidies place on the government's finances. Although the panel partially agreed, there's a call to revisit the flat rate of subsidies, distinguishing between different beneficiaries based on need and economic factors for a gradual removal.

Question-2. Why has Public-Private Partnership (PPP) in power plants not been expanded?

Answer: While acknowledging the success of existing PPP-operated plants, the panel agreed that the scope for PPP expansion could have been greater. It was suggested that private partners might have preferred independent operations.

Question-3. Do you think coal mining is the better option than offshore gas exploration?

Answer: Panelists emphasized that these are distinct endeavors dependent on factors like entities involved, exploration methods, and cost-benefit analyses. A pilot project for coal exploration using an open-pit method was suggested to reduce reliance on the international coal market.

Question-4. What are the challenges of storing solar energy in Bangladesh?

Answer: Given the limitations in large-scale solar energy storage, the suggestion involved reshaping the demand curve by encouraging maximum solar energy usage during the day, potentially through lifestyle changes and awareness programs.

Question-5. Is it possible to use idle spaces on and around the highways for installation of solar panels?

Answer: A proposal to utilize idle spaces along highways for solar panel installations was highlighted as a potentially effective solution, which could be considered by the government.

Question-6. What is your opinion about the viability of captive power plants?

Answer: While captive power plants are operational, concerns lingered about transparency and whether excess electricity generated within factories is adequately shared with the national grid.

Question-7. Why do you think of increasing generation capacity despite a surplus currently?

Answer: Forecasts indicate a significant increase in energy demand by 2041 due to projected economic growth. To match this growth and maintain pace with development, enhancing generation capacity is deemed necessary.

Question-8. You have shown that the initial cost of establishing renewable energy system is comparatively high. Why is that so and what could be done to make it afordable?

Answer: Despite renewable energy being relatively cheaper globally, it was noted that higher costs in Bangladesh were due to tariffs, lack of significant government sponsorship, and a monopoly in fossil-based power generation. A policy shift was suggested for affordability.

Question-9. What is your opinion regarding international commitments like the Paris Climate Agreement?

Answer: The discussion underscored the need for Bangladesh to align with international agreements and work on an energy transition plan, emphasizing the importance of regional and international partnerships to achieve Vision 2041.

Question-10. Was gender impact considered in the planning of renewable energy usage?

Answer: While the overall impact of renewable energy was considered for all genders, the discussion acknowledged a lack of comprehensive consideration of gender lenses throughout the planning process.

Question-11. What would be the impact of climate change on power generation and distribution?

Answer: The shift toward renewable energy is aimed at mitigating the impact of climate change on power generation, aligning with sustainability goals.

Question-12. What efforts are being made to address the recycling of solar panels at the end of their life cycle?

Answer: Bangladesh is working towards acquiring more solar energy capacity, with plans to evolve solar panel recycling capabilities using appropriate technologies in due time.

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21	Captain Mahmudul Haque Majumder, (L), NPP, afwc, psc, BN	Directing Staff (Navy)
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25	Lieutenant Colonel Md Sahariar Morshed, afwc, psc, Inf	General Staff Officer-1 (AFWC)
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28	Major Syed Arshad Ahmed, Arty	Company Commander
30	Major Yasin Ali Siddiqui, Inf	General Staff Officer-2 (Administration)
31	Major Md Mesbahuddin Russel, ASC	Mechanacal Transport Officer
32	Major Md Shakhawat Ali, Arty	General Staff Officer-2 (Planning & Coordination)
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34	Major Mohammad Saiful Islam, Sigs	General Staff Officer-2 (Network Administrator)

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37	Major Md Nurul Kamal, Engrs	General Staff Officer-2 (Accounts)
38	Major Md Jahir parvez Shohag, Arty	General Staff Officer-2 (Coordinator)
39	Major Khan Mohammad Shafiul Islam, Inf	Coordinator (SDS Army)
40	Major Tanvir Rony, Inf	Coordinator (SDS Army)
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42	Lieutenant Commander Snahalota Ray (Edn), BN	General Staff Officer-2 (Training Support)
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44	Deputy Secretary Md Golam Zakaria	Research Coordinator
45	Captain Mahathir Mostafa Nabil, Arty	ADC to Commandant
46	Captain Mahmud Emtiaj Rasel, AC	Staff Captain
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48	Flight Lieutenant Rifat Bin Reza, BAF	Coordinator (SDS Air)
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2	Brigadier	M A Shaik	India
3	Commodore	Saurabh Thakur	India
4	Air Commodore	PVS Narayana, F(P)	India
5	Colonel	Rachmadi Anggoro, S.E, M.Sc, S.S	Indonesia
6	Colonel	Zuhier Ahmad Fayiz	Jordan
7	Colonel	Joel Mugambi Kirimi	Kenya
8	Staff Colonel	Khalid Mohammed Alshehri	KSA
9	Captain	Ahmad Faea Alasiri	KSA
10	Staff Lieutenant Colonel	Turki Salem Alarjani	KSA
11	Staff Colonel	Abdullah Ali Alshehri	KSA
12	Lieutenant Colonel	Bandar Sager A. Alsabti	KSA
13	Staff Colonel	Badr Hamed F Alangari	KSA
14	Captain	Syanaz bin Ibrahim	Malaysia
15	Lieutenant Colonel	Talibe Konte	Mali
16	Colonel	Subash Jung Thapa	Nepal
17	Colonel	Abdoulaye Hamadou Mle, OA/ SM	Niger
18	Colonel	OA Eneonwo	Nigeria
19	Captain	Musa Danjuma Jarma	Nigeria
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22	Captain	Khalid bin Khalfan bin Ali Al-Maqbali	Oman

23	Group Captain	Rashid bin Hamdan Bin Said Al Kalbani	Oman
24	Brigadier	H D L S Perera, RWP, RSP	Sri Lanka
25	Air Commodore	AV Jayasekera	Sri Lanka
26	Brigadier General	Duol Gony Riek	South Sudan
27	Colonel	Khalid Ibrahim Hamed Suliman	Sudan
28	Colonel	Longinus Edmund Nyingo	Tanzania
29	Colonel	D Kapisha	Zambia

Bangladesh Army		
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44	Brigadier General	Muhammad Malek Hossain, psc
45	Brigadier General	Md Tariqul Islam, PBGMS, psc
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69	Air Commodore	Md. Asad-Uz-Zaman, afwc, psc, ADWC
70	Air Commodore	Abu Sayeed Mehboob Khan, BUP, psc, GD(P)
71	Air Commodore	Md Moinul Hasnain, BUP, afwc, psc, Engg
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74	Additional Secretary	Yasmeen Parveen
75	Additional Secretary	Md Rabiul Islam
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77	Joint Secretary	Md. Aminul Islam
78	Joint Secretary	Salma Siddiqua Mahtab
79	Joint Secretary	Abu Saleh Md Mohiuddin Khan
80	Joint Secretary	Nazma Begum
81	Joint Secretary	Mohammad Abdul Ahad
82	Joint Secretary	Mst. Sultana Pervin
83	Deputy Inspector General	Paritosh Ghosh
84	Deputy Inspector General	Md. Golam Roufe Khan, PPM (BAR)
85	Director General	Md Iqbal Hussain Khan

Outside Participants

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2	Lieutenant Colonel Bakhtier	Armed Forces Division
3	Commander Asad	Armed Forces Division
4	Colonel Khair	Armed Forces Division
5	Colonel Selim Azad	Army Headquarters
6	Lieutenant Colonel Nazmul	Army Headquarters
7	Lieutenant Colonel Rownak Azam, psc, G+	Army Headquarters
8	Commodore Mohidul Hasan	Naval Headquarters
9	Captain Abdus Salam	Naval Headquarters
10	Air Commodore Ziaul Hasan	Air Headquarters
11	Air Commodore Hannan	Air Headquarters
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13	Nahian Reza	Bangladesh Institute of International and Strategic Studies
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15	Brigadier General Monir	Bangladesh University of Professionals
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17	Lieutenant Colonel Md Kamrul Hassan	Defence Services Command & Staff College
18	Brigadier General Towhid	Military Institute of Science & Technology
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