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Review of Coal Fired Power Plants in Bangladesh

S Ahammed1, MR Rana1, MA Rony1, MM Hosain1, MA Mamun1, M Alauddin1, MM Mahmood1, N Haque1, Z Mahabub1, MM Rahman1, MS Islam1, MN Uddin1*, R Roy2, MM Rashid2

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Abstract:
This article is based on the current and future coal power plants of Bangladesh. Although, it is known to all that, coal fired power plants are the great sources of carbon and other pollutant ingredients. But it has several positive impacts for developing countries like Bangladesh, where there is a lack of natural resources, lands and unstable economy. Bangladesh government has a vision to supply the electricity all over the country of Bangladesh, from Teknaf to Tetulia, and also for the remote islands also. In this paper, energy demand and vision of Bangladesh government is discussed in section 1. Section 2, gives the answer, why coal fired power plant is necessary for Bangladesh. In section 3, impacts of coal fired power plant is discussed and showed all current power plants in a table. Section 4 comprises with the future of coal fired power plant in Bangladesh.

Keywords—Coal fired power plant, Barapukuria, CPGCBL future projects, Matarbari, Payra**.**

I. INTRODUCTION

This article is about the study of recent coal fired power plants and their future impacts. All of we know that, energy, environment and socio-economy are related to each other. These are the prime factor for sustainable socio-economic development. In Bangladesh, as of June 30, 2018, generation capacity is around 18,753 MW including captive power generation. According to Power System Master Plan (PSMP) 2016, in base case and using GDP elasticity method it is estimated that electricity demand will reach to around 14,500 MW by 2021, 27,400 MW by 2030 and 51,000 MW by 2041. As the domestic gas reserve is reducing day by day, government is considering fuel diversification in electricity generation. As a part of fuel diversification in electricity generation, 35% of the electricity would be generated from coal as primary energy by 2041. Considering the future electricity demand, Government has taken initiatives to construct around 9000 MW by 2030 and 20,000 MW by 2041 coal based power plants both in public and private sector [1].
Coal Power Generation Company Bangladesh Limited (CPGCBL) will likely to be contributing around 5000 MW power to National Grid from its coal based power plants by 2030.

To develop a policy of power source diversification in the power sector, the government has made strategy to expand coal-fired thermal power stations (CTPP) for power generation focusing on not only domestic coal but also imported coal. In conventional coal-fired power plants, coal is first pulverized into a fine powder and then combusted at temperatures of between 13000C to 17000C. This process heats water in tubes in the boiler so that it becomes steam at a pressure of around 180 bars and a temperature of 5400C. This steam is passed into a turbine to produce electricity. Pulverized coal power plants account for about 97% of the world's coal-fired capacity [2]. Subcritical, Supercritical (SC), Ultra-supercritical (USC), Integrated Gasification Combined Cycle (IGCC) and Subcritical circulating/pressurized fluidized bed combustion (FBC) technologies are used to generate electricity from coal. Subcritical technology covers 74.50% and then SC. Supercritical (SC) and ultra-supercritical (USC) technology based coal power plants require less coal, leading to lower emissions (including CO2 and Hg), higher efficiency and lower fuel costs per kWh also steam coal power plant.

II. NECESSITY OF COAL FIRED POWER PLANTS IN BANGLADESH

Coal is used widely as a fuel source for electricity generation. It is one of the major primary energy resource for electricity generation in the world. From the mid of 18th to the mid of the 19th century, coal got extracted from the nature and will be the principal source of energy in the west, mainly coal introduced the industrial revolution to Europe in that century [3]. Captive Coal-fired thermal power Plant (BTPP) site is located, at Barapukuria, Parbatipur Upazila, in flat land of the northwestern region of Bangladesh at about 45 km east of the district headquarters of Dinajpur, 20 km east to the border of India. The site is placed about 1 km north of the Barapukuria coal mine (BCM) mouth. As the natural gas is the main source of electricity generation is about 58.89 % and government has a plan to reduce the consumption of natural gas by alternating into another source. The country relied almost exclusively on its own natural gas resource for power

generation. Cheaper own gas and low-priced power acted as the backbone of the national economy. But the proven reserve of own natural gas is firstly depleting. The remaining recoverable reserve of 14 Tcf would are expected to completely deplete by 2030 [4]. As a part of this step, Rooppur nuclear power plant is a great project which will be commissioned by 2022 of its first unit and 2023 of its 2nd unit. But Bangladesh government has a vision to turn its economy into mid-income country. Therefore, a lot of industry and exclusive economic zone is under construction. To meet the necessity of its power sector, electrical energy is a must. On the contrary natural fossil fuel are limiting day by day.

With US$ 50/barrel price, imported oil may be out of reach of common people in the country soon in 2016 [5].World energy statistics shows that oil 1697.6 billion barrels (Bbl), gas 186.9 trillion m3 (Tcm), coal 891531 million tonnes (Mt) reserves and these will meet the world demand 50.7, 54.8 and 114 years respectively [2]. There are very few alternative options rather than coal power plant because of the geographical position, uprising economy and unavailability of natural resources. Other imported fossil fuel is too expensive with volatile and unstable prices. No alternate option except power generation from coal in the shortest period of time and also more abundant resource in many parts of the world. So, coal power plant is a favorable option to boost its energy sector. Although coal fired power plant emits a lot of carbon and that's why most upgraded technology will be implemented which will enhance its efficiency and reduce the carbon emission. Bangladesh's only coal-fired power plant, in Dinajpur's Barapukuria, established near the coal mine, procures 80% of the coal for using in the existing two units of the power plants combined 250 MW. The third unit, with a capacity to produce 275MW.The thermal power plant can generate 525MW.[6].

III. IMPACTS OF COAL FIRED POWER PLANTS

The country has five coal fields (bituminous to sub bituminous coal), namely Barapukuria, Dinajpur; Khalaspir, Rangpur; Phulbari, Dinajpur; Jamalganj, Jaipurhat and Dighirpar, Dinajpur. Barapukuria coal basin is one of them which is a under underground mining. . The country has about 3.33 Bt of superior quality bituminous to sub bituminous coal reserve [7]. Combustion of coal in thermal plant is one of the major sources of environmental pollution due to production of large amounts of ash residues and gaseous and particulate matters. Barapukuria coal fired power plant generates around 10-15% ash residues (FA 57%, BA 17%, BS <2%, FGD gypsum 24% [8] of its feeding coal. Coal and coal waste products, including CCRs, bottom ash, and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and, radium, which are dangerous if released into environment. Large amounts of coal combustion byproducts are usually deposited in ash ponds which have a significant environmental impact by consuming huge areas of land, and releasing dusts. Major portion of these heavy metals may remain with ash. B, As, Hg toxic elements are rich in ash pond which have a tendency to spread out into the soil and groundwater over a period of time. Hg concentration high in water and some minute amount of Hg may remain in the power plant discharge water even after treatment. It is more toxic and cause severe health problem. Mercury emission from coal burning is converted into methyl mercury, a toxic compound that harms people who consume freshwater fish. CCRs are disposed to the nearest ash disposal mound (PA). These wastes contain highest contaminants which leached to the sub ground with waste water following the geochemical processes such as oxidation, dissolution, dilution, diffusion, ion-exchange, adsorption reaction, precipitation, redox associated with hydrogeological and pedological processes. Some gaseous and particulate matters (PM) emitted to the air as flu gas through the chimney and some of it settle and precipitate. From the disposal site ash, it may be not only leached out to the ground but also emitted to the atmosphere too. During high speed tropical cyclone/wind, these suspended coal nanoparticles like PM, coal dust, CCRs, and volatile matters can spread out over a large area and resettle down, reprecipitate on the ground. In Bangladesh, share of commercial energy will be 1.58 Mtoe (5%) in 2015 and targeted to be 19.18 Mtoe (27%) in 2021 from coal [9]. As a result, these plants will likely produce large volume of pollutants (fly and bottom ash) that will great impact on hydrogeological, geological and ecological system especially soil and water resources. In figure 1.1(a) has shown coal burning statistics in different part of the world while China is the most producing and consuming country (50.2%) and generated a large volume of ash residues (figure 1.1 and 1.2) ash forming processes is elaborated in . Clean coal is a concept for processes or approaches that mitigate emissions of different gaseous like CH4, N2O, SO2, CO2 , particulate matter, natural radioactive elements and other trace elements that arise from the use of coal, mainly for electricity generation. In Bangladesh, most of the studies have been conducted within 4 to 5 yrs following the installation of plants but very limited study on CCRs characteristics and its response to the water resources environs. To find out the effect or impact of the power plant, such a period is too short for meaningful and conclusive investigation to be made. Trace elements in native coal need to be examined as well as the CCRs generated from the coal-fired thermos-electric power stations. Groundwater and soil around the coal plant need to be studied deeply in all aspects. This is necessary if precautions are to be taken during the construction of new large scale power plants and minimize and mitigate the harmful substances from the potential pollution.

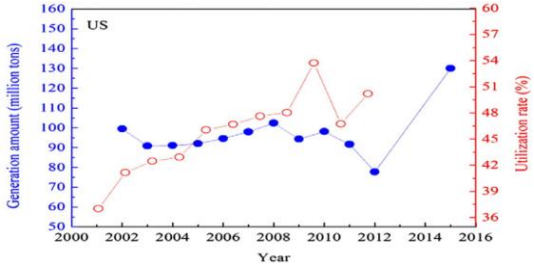

Fig. 1(a) : The generation and utilization of FA worldwide

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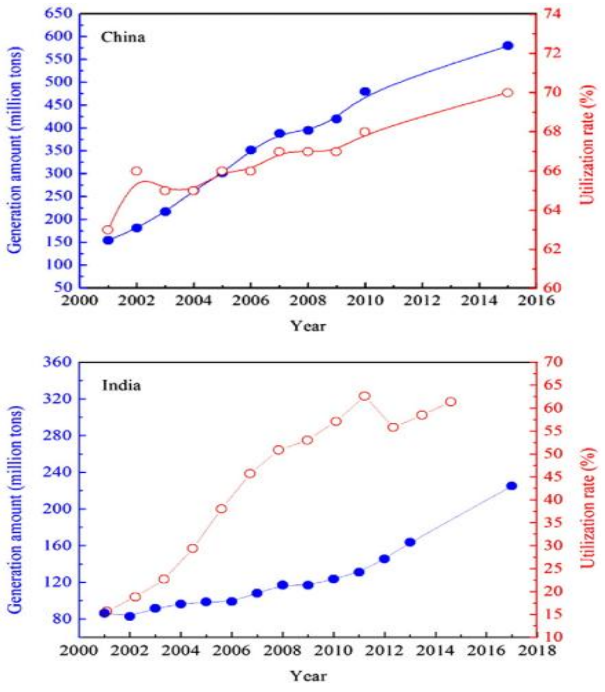
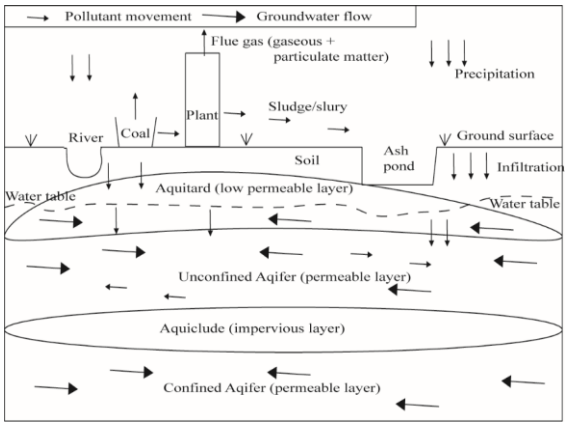


Yao et al., 2015

Fig. 1(b) : The generation and utilization of FA worldwide

Some researchers on BTPP showed a number of coal ash contaminants such as major and minor oxides and anion/cations like sulfate (SO42-) and fluoride (F-) anions are within the acceptable limits. . In the long run, coal combustion wastes from these power plants are likely to impact significantly on the environment, economy, energy, health (mortal disabilities, lunge diseases, even cancer too) and even the agricultural system. The suspended particulate matter (SPM), which is emitted from the combustion of coal that impacts on human health especially the liver, kidneys disease, lung cancer, cardiovascular disease, nervous system and internal organs. Water environs are affected by the CTPPs solid waste pollutants. Researchers and environmentalists say that the impact of Rampal coal fired power plant will be beyond description. It will affect on the ecology of Sundarban. And it is also considered a threat on the environment of surroundings.



Source: Habib at el,2019

Fig. 2: A schematic illustration of pollutants sources and pathways of CTPP

A. Current Coal fired power plant projects of Bangladesh

Table 1: **Current Coal fired power plant projects of Bangladesh**

Plant	Org.	Status	Proposed Date	MW	Fuel
Barapukuria 3rd Unit	BPDB	Approved by the Cabinet "Purchase Committee"	March 2016	250	coal
Chittagong power station	Orion Group	BPDB states "Contract Signed with Orion Group on 27.06.2012"	March 2016	283 MW	Imp. coal
Khulna South power station	Orion Group	BPDB states "Contract Signed with Orion Group on 27.06.2012"	March 2016	1300	Imp. coal
Khulna	Orion Group	BPDB states "Contract Signed with Orion Group on 27.06.2012	March 2016	283	Imp. coal
Maowa power station	Orion Group	BPDB states "Contract Signed with Orion Group on 27.06.2012	July 2016	522	Imp. coal
Mongla power station	BPDB	-	-	1320	coal
Rampal power station	BPDB and National Thermal Power Corp.	-	-	1320	coal
Matarbar-i power station	Bangladesh Power	-	September, 2017	1200	Imp. coal
Payra Thermal Power Plant Project (1st Phase) (Under JVC)	NWPGCL	-	1st Unit: December, 2019 2nd Unit: June, 2020	1320	Imp. coal

B. Other Impacts

India and Bangladesh, heavily depend on groundwater for irrigation and drinking but it is also losing due to contamination and overuse [10]. Major air pollution (about 68%) is caused due to the fossil fuel combustion in the world [5] while coal contribute more than 45% in 2014. Water and energy are the two most critical resources which is receiving more and more from the academia as well as the public in global, regional, national, and local level. Increasing amounts of trash and waste is greately stressed on environment. More than 97% of the world's water is in the form of salt

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water; 2% is in the form of glaciers, ice cpas, and snow, and less than 1% is easily acessible for human use. The worlds total water is made of 97.5% of oceans, and 2.5% of fresh water. and of the 2.5% of the fresh water: 68.7% is glaciers, 30.1% is groundwater, 0.8% is permafrost, and 0.4% is surface and atmospheric water [11]. More recently, however, three trends have perhaps irreparably altered this natural balance: population growth, which has created shortages of drinkable water where it is needed most; and greater reliance on CTPPs, which use and degrade water in a variety of ways.

IV. COAL FIRED POWER PLANT AND THE FUTURE OF BANGLADESH

The general public is more concerned and worried about the very recent installation of more CTPPs in the country, 23 coal power stations successively. The prime initiative of Coal Power Generation Company Bangladesh Limited (CPGCBL) is to construct a 2x600 MW Ultra Super Critical Coal Fired Power Plant at Matarbari in Maheshkhali Upazilla of Cox's Bazar District. This project comprises of construction of Jetty and Coal Handling facilities for coal import, coal storage, power plant construction, township development, rural electrification, construction of transmission facilities and road communication. Environmental and Social Impact Assessment (ESIA) and feasibility study of this project were conducted on the year 2013-2014. Implementation of this project will increase electricity Power generation, create employment opportunity and develop skilled manpower through transfer of modern technology. The second initiative of this company is to construct the first phase of Bangladesh-Singapore 2x700 MW Ultra Super Critical Coal Fired Power Plant.

1. Matarbari 2x600 MW Ultra Super Critical Coal Fired Power Plant Project progress:

1608 acres of land has already been acquired for the construction of 2x600 MW Ultra Super Critical Coal
Fired Power Plant including port facility. CPGCBL has appointed a consultancy firm "Matarbari Joint Venture Consultant (MJVC)" to act as Owner's Engineers. MJVC prepared the technical specifications, drawing of power plant and port facility, Bid Document for EPC (Engineering, Procurement and Construction) contractor. The consortium of Sumitomo Corporation, Toshiba Corporation and IHI Corporation is engaged as EPC contractor for construction of 2x600 MW Ultra Super Critical Coal Fired Power Plant on 27th July 2017. The EPC Contractor has started the power plant construction works on 22th August 2017.
Honorable prime Minister of the govt. of the People's Republic of Bangladesh has laid down the foundation Stone of Matarbari 2x600 MW Ultra Super critical coal fired power plant on 28th January, 2018. Physical progress of the project is about 17.76% up to June 2018 at present progress of the project is about 19.71% [12].

Fig. 03 : Matarbari 1200 MW Power Plant

2. Kohelia 700 MW USC Coal Fired Power Plant:

A 700 MW USC Coal Based Power Plant (1st Phase of Kohelia 2x700 MW USC Coal Fired Power Project) will be constructed by CPGCBL and Kohelia Singapore Holding Private Limited (KSHPL) jointly at Matarbari. To implement this project around 1350 Acres land has already been acquired. Technical Feasibility Study (FS) of this project has been completed and Environmental and Social Impact Assessment (ESIA) study Preparation is in progress. Fichtner GmbH & Co. KG, Germany has been appointed as Owner's Engineer on May 30, 2018.
[12].

3. CPGCBL-Sumitomo 1200 MW USC Coal Fired Power Project:

Coal Power Generation Company Bangladesh Limited is also exploring the possibility to set-up 1200 MW Ultra Super Critical Coal Fired Power Plant Jointly with Sumitomo Corporation, Japan in Moheshkhali area. In this regard, a Memorandum of Understanding (MoU) has been signed between CPGCBL and Sumitomo Corporation, Japan on 5th October, 2017. Around 1500 acres of land has already been identified to establish this Power Project and Land Acquisition proposal has been submitted to DC Office, Cox's Bazar. Approval of Development Project Proposal (DPP) for Land Acquisition and related activities for construction of CPGCBL-Sumitomo 1200 MW Ultra Super Critical Coal Fired Power Plant is in progress [12].

Fig. 04 : Proposed place for Sumitomo 1200 MW power plant

A. Future coal fired project plan of CPGCBL

Table 02: CPGCBL and NWPGCL Future coal fired Project

Sl.	Project name	MW	Proposed Date	Fuel	Company Name
1.	Bangladesh-Singapore ultra supercritical coal fired power plant (phase-1)	700	2025	Imp. coal	Sembcorp Utilities Pte. Ltd.
2.	Bangladesh-Singapore ultra supercritical coal fired power plant (phase-2)	700	2030	Imp. coal	Sembcorp Utilities Pte. Ltd.
3.	CPGCBL-Sumitomo 2*600 ultra supercritical coal fired power plant	1200	2026	Imp. coal	Sumitomo Corporation, Japan.
4.	Dighipara Ultra Super Critical Thermal Power Plant Project (Under NWPGCL)	1000	June, 2025	coal	

Source: CPGCBL& NWPGCL

IV. Conclusion

Coal is vastly available all over the world. On the other hand, natural gas or oil is depleting day by day. From this point of view, coal is suitable for developing countries like Bangladesh, where there is lack of available land for solar power plant, lack of available wind to run wind turbine and lack of technical and research opportunities to harness energy from the ocean. The innovative, efficient and effective technologies and sustainable measures must be considered to manage, control and remediate the adverse impacts. There are major environmental issues relating to coal exploitation, transportation, storage, and consumption in power plants and industries, disposal of ash residues, flue gas emission and heat pollution.

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AUTHORs PROFILE

MN Uddin (Md Nasir Uddin) is an Assistant Professor in Northern University Bangladesh. He is from Gazipur, Dhaka, Bangladesh. He is corresponding & main Author.
Email: engnasirbd@gmail.com

Shakil Ahammed is a Teaching Assistant in Northern University Bangladesh. He is from Cumilla, Bangladesh. Coordinator & member of NUB IEEE Student Branch.
Email: ahammedshakilbd@gmail.com

MR Rana is studying MS in BUET.
Email: rubelranaeee274@yahoo.com

MA Rony completed his BSc in EEE from Northern University Bangladesh.
Email: ronys911@gmail.com

MM Hosain is a student of Northern University Bangladesh.
Email: mosharofadnan96@gmail.com

MA Mamun is a student of Northern University Bangladesh.
Email: mamunal9968@gmail.com

MM Mahmood is a student of Northern University Bangladesh.
Email: moontasir.mahmood88@gmail.com

Nurullah Haque is a student of Northern University Bangladesh
Email: nurullainboxs@gmail.com

MM Rahman is a student of Northern University Bangladesh.
Email: mohiburrahman65@gmail.com

MS Islam is a student of Northern University Bangladesh.
Email: sirubel1993@gmail.com

MM Rahman is a student of Northern University Bangladesh.

Md Alauddin is a student of Northern University Bangladesh.
Email: eng.alauddin12@gmail.com