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Impacts of Coal Based Power Station in Bangladesh

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Abstract

The research work is an effort to find various impacts on the environment, ecosystem, life cycle, plants and animals for using coal. It is already declared by the reputed geologist and geo scientists of the world that coal should not be used anymore in the world even the rest coal lying under the earth should not be explored anymore. The characteristic of the world having cool weather, ecosystem, life cycle etc. are the result of having coal under the earth. Coal is considered as an integral part of the earth to manifest all these characteristics. When coal is explored, the earth loses a vital part of the earth which results a deviated character and at the same when the explored coal is burnt it makes the world more badly. If we go through the comparison table of pollutants emission by different fuel, we will see in quantity and type coal is worse emitter fossil fuel in the world. Especially a country like Bangladesh having an alluvial almost flat fertile land and with so many rivers, creeks, canals, it is quite likely that use of coal in any locations and plants will destroy the total lands including its environment and ecosystem. It is observed that a coal based power station is more dangerous in all respect. The coal based power station has much more environmentally harmful in comparison to any other power stations. So, Emission of CO2, NO_2 and SO_2 from coal based power station which causes acid rain and Greenhouse effect should not be operated anymore. However, to get remedy of this dangerous situation we can use Coal Bed Methane (CBM) and Underground Coal Gasification (UCG) process. Renewable energy is the best attempt to produce electricity to keep the world comfortable for human living. We should take effective plan to replace the fossil fuel based power generation by clean and renewable resources where Bangladesh has enormous quantity of renewable resources.

Keywords

Coal Bed Methane (CBM), Underground Coal Gasification (UCG), Inexhaustible Resource, Physicochemical

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1. Introduction

Electrical energy is an auspicious element to improve industrial growth, quality of living standard of the people and for overall development of the economy. It is a key player of all developments in the world. Security in energy supply becomes the main issue for all of the countries since the limitation of fossil fuels and high dependence on them. Problems in the energy sector also in terms of environmental emissions since the energy sector is the main contributor to global warming. [1]

1.1. Generation of Electrical Energy

Energy is available in various forms from different natural resources such as pressure head of water, chemical energy of fuels, nuclear energy of radioactive substances etc. All these forms of energy can be converted into electrical energy by use of suitable arrangements. The arrangement essentially employs an alternator coupled to a prime mover which is driven by the energy obtained from various sources such as burning of fuel, pressure of water, force of wind etc. [2]

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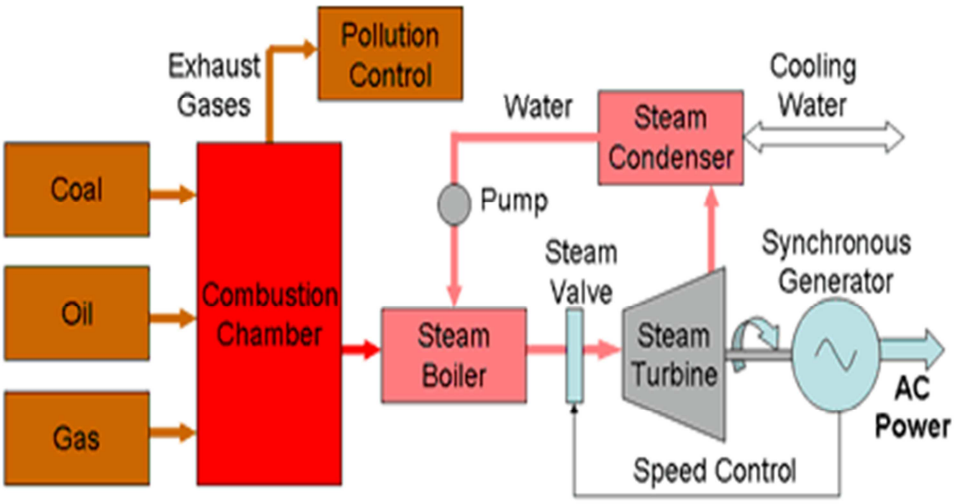

Figure 1. Fossil Fuel powered steam Turbine Electricity Generation.

1.2. Electricity Sector in Bangladesh

Bangladesh's energy infrastructure is quite small, insufficient and poorly managed. According to Bangladesh Power Development Board (BPDP) the Present Generation Capacity 13,151 MW as on 01 January, 2017 [3]. Most of the power plants are gas and coal based which will be phased out in future. There is a 250MW government-run coal-based power plant at Barapukuria in Dinajpur. Installation of another coal base power plant unit of 250 MW at the same premises was supposed to be set up. The government promised to set up a total of eight coal-fired power plants under their and private initiative. Of them, the local private firm Orion group was supposed to build three 1,088 MW coal-based power plants, another two 1450MW power plants under the government initiative while three more 7960MW plants as joint-venture. The government also initiated to set up a 1320MW coal-fired plants at Rampal with the National Thermal Power Corporation of India [4].

2. Coal

Coal is a flammable black hard rock used as a solid fossil fuel. It is mainly made up of 65-95% carbon and also contains hydrogen, sulphur, oxygen and nitrogen. It is a sedimentary rock formed from peat, by the pressure of rocks laid down later on top, therefore coal is formed from the remains of plants which lived millions of years ago in tropical wetlands, such as those of the late Carboniferous period (the Pennsylvanian). A similar substance made from wood by heating it in an airless space is called charcoal. [5]

Coal, the second source of primary energy (roughly 30%), is mostly used for power generation (over 40% of worldwide electricity is produced from coal).

2.1. Coal Types

Mostly used coals in Bangladesh for power generation are Bituminous and Sub-bituminous coal. [6]

1. Sub-bituminous coal whose properties range from those of lignite to those of bituminous coal, is used primarily as fuel for steam-electric power generation and is an important source of light aromatic hydrocarbons for the chemical synthesis industry.
2. Bituminous coal is a dense sedimentary rock, usually black, but sometimes dark brown, often with well-defined bands of bright and dull material; it is used primarily as fuel in steam-electric power generation, with substantial quantities used for heat and power applications in manufacturing and to make coke.
3. Peat A mass of recently accumulated to partially carbonized plant debris. Peat is an organic sediment. Burial, compaction, and coalification will transform it into coal, a rock. It has a carbon content of less than 60% on a dry ash-free basis.
4. Lignite Lignite is the lowest rank of coal. It is a peat that has been transformed into a rock, and that rock is a brown-black coal. Lignite sometimes contains recognizable plant structures. By definition it has a heating value of less than 8300 British Thermal Units per pound on a mineral-matter-free basis. It has a carbon content of between 60 and 70% on a dry ash-free basis. In Europe, Australia, and the UK, some low-level lignites are called "brown coal."
5. Anthracite Anthracite is the highest rank of coal. It has a carbon content of over 87% on a dry ash-free basis. Anthracite coal generally has the highest heating value per ton on a mineral-matter-free basis. It is often subdivided

into semi-anthracite, anthracite, and meta-anthracite on the basis of carbon content. Anthracite is often referred to as "hard coal"; however, this is a layman's term and has little to do with the hardness of the rock.

2.2. Environmental Impacts of Coal

According to the Union of Concerned Scientists, in an average year, due to directly burning of coal a typical coal plant (500 megawatts) generates the following environmental impacts in order to produce electrical energy. [7]

1. 3.7 million tons of carbon dioxide (CO_2), an amount equivalent to chopping down 161 million trees. CO_2 pollution is the principal human cause of global warming and climate change.
2. 10,000 tons of sulphur dioxide (SO_2), which causes acid rain and forms small airborne particles that can cause lung damage, heart disease, and other illnesses.
3. 10,200 tons of nitrogen oxides (NOX), equivalent to half a million late-model cars. NOX leads to formation of smog, which inflames lung tissue and increases susceptibility to respiratory illness.
4. 500 tons of small airborne particles, which can cause bronchitis, reductions in lung function, increased hospital and emergency room admissions, and premature death.
5. 220 tons of hydrocarbons, which contribute to smog formation.
6. 720 tons of carbon monoxide (CO), which causes headaches and places additional stress on people with heart disease.
7. 170 pounds of mercury. 1/70th of a teaspoon of mercury deposited in a 25-acre lake can make the fish unsafe to eat. Mercury also causes learning disabilities, brain damage, and neurological disorders.
8. 225 pounds of arsenic, which leads to cancer in 1 out of 100 people who drink water containing 50 parts per billion.
9. 114 pounds of lead, 4 pounds of cadmium, and other toxic heavy metals. These toxic metals can accumulate in human and animal tissue and cause serious health problems, including mental retardation, developmental disorders, and damage to the nervous system.

3. Methodology

The research based on field observations and data collection. Coal, soil and drain water samples were observed from the study area for sampling. Coal sample and soil data are observed from Barapukuria Bangladesh thermal power plant.

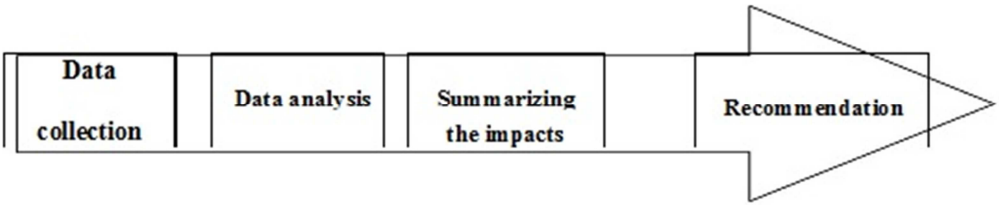

Figure 2. Analysing Steps.

3.1. Data Collection and Analysis

The research covers both secondary and primary data. Here secondary and primary data sources are used to estimate the emissions and their effects from Barapukuria thermal power plant.

Primary Data: Primary data were collected from the the surrounding area within about 5km from the power plant. A conversation was made among 165 people of different profession nearby the plant area to investigate the impact on their health. They informed about their health condition (suffered by the Barapukuria power plant). The survey was based on several questions about asthma, allergy, skin diseases, and other respiratory problems on their health impact.

Table 1. Health impact on inhabitants (degree of responsive analysis).

Variable	Asthma	Allergy	Skin	Other	Total	Percen-tages %
			Dise-ases	Respire-tory problem		
Agree	5	7	6	12	30	18.18
Undeci-ded	10	23	24	28	85	51.51
Dis-agree	20	10	10	10	50	30.30
Total	35	40	40	40	165	100

Secondary Data: Secondary data were collected from the authority of Barapukuria thermal power plant, sequentially from the water treatment plant, Power Use department, coal & ash handling unit.

Table 2. Analysis of Waste water (Drained).

Water	Gut side	Outside
parameters	boundary drain water	drain water
Mn	0.19 mg/L	0.26mg/L
pH	7.2	7.4
Total count	7.5x104 C.F.U/100mL	10x104 C.F.U/100mL
Total coliform	28	28
Fecal coliform	9	9
As	0	0
SO_4^{2-}	2.4mg/L	3.1mg/L
$NO^{3-}N$	0.4mg/L	1.6mg/L
Fe^{3+}	0.45mg/L	0.61mg/L

Table 3. Amount of chemical analysis.

Oxides	Percentage
SiO_2	54.4
Al_2O_3	35.6
Fe_2O_3	2.9
TiO_2	3.2
Mn_3O_4	0.11
CaO	0.56

Table 4. Inspection Report (BCPS, Date:21.01.2016).

Power Station capacity	No of Unit	Unit Capacity	Land Area	Cost of power Station	Cost of land	Cost of Total installation	Future Capacity
2×125MW	2	125MW	190 acre	22000 core	580 core	2200 core	250MW (1 unit)
Cost per Mw for installation	Type of power station	Cost of PU Power production	Heat Developed	Cooling mechanism	Cooling water intake/outtake Mechanism	Water source	Emission due to Coal
88 core	Coal based	4.16 Tk	6300kcal/kg	Cooling tower	Intake =Deep tube well and canal, out take canal	Deep tube well and canal	CO_2, SO_2, CO, NO_2 etc.
Fuel used	Fuel source	Fuel Price	Fuel Transport Mechanism	Cost for Fuel Transport	Fuel Required Per day	Fuel storage mechanism	Fuel Store to P/S Transport
Bituminous and HSD	Barapukurai Coal Mine	$130/MT	Transport Truck and Conveyor Belt	BDTk.100.00/Ton	2400 MT for design, Actual 2000 MT	Transport Truck and Conveyor Belt	Conveyor Belt
Storage Mechanism	Reserve Storage for Days	Land Ratio between Storage and P/S	Coal quantity	Heat Quantity	Ash Quantity	Carbon	Methane
Open Field	6-12 month	10:100	0.4 Kg/Kwh	6100Kcal/Kg	12.4%	48.4%	12% of Coal
Quantity of Coal for PU Power	Cost of Coal for PU Power	Total No Staff	Technical Staff	Accounts staff	Admin staff	Pollutants due to Coal	Side effects for worker
0.4 Kg/Kwh	BD Tk. 5.70	276	193	40	43	CO_2, SO_2 NOX	3 Workers
Impact of Coal burning in Environment, Agri Rivers & Water	What is Clean Coal Technology	Critical & super Critical Technology	Underground coal gasification	Total Moisture	Total Sulphur	Water Consumption Per hour	Manufacturer of Major Equipment's
Harmful	Not Replied	Not Replied	Not Replied	10%	0.53%	800-1200MT	Boiler/Turbine/Generator *China*, Control system *USA, Germany*

3.1.1. Plant Capacity & Power Evacuation System

1. plant Capacity:2×125MW

2. Generating Voltage:13.8KV

3. Unit Step-Transformer:2×156.25MVA, 13.8/230KV

3.1.2. Outgoing Feeders

a. Double Circuits 230 KV to Bogra.

b. Double Circuits 132 KV to Saidpur.

c. Double Circuits 132 KV to Rangpur.

3.1.3. Manufacturer of Major Equipment's

#Boiler: Shanghai Boiler Works, China

#Turbine: Shanghai Turbine Co, China

Generator: Shanghai Turbine Generator Co., China

Control System: ABB, Bailey, USA & Siemens, Germany

3.1.4. Characteristics of Coal

Table 5. Proximate Analysis (Average Characteristics of Whole Steam).

Fixed Carbon	48.4%
Volatile Matter	29.2%
Ash	12.4%
Total Moisture	10.0%
Total Sulphur	0.53%
Gross Calorific Value	6100kcal/kg

Table 6. Ultimate analysis (Dry Ash Free Basis).

Carbon	83.0%
Hydrogen	5.1%
Oxygen	9.4%
Nitrogen	1.7%
Sulphur	0.53%
Total	99.73%

Table 7. Chemical Composition of Coal (Bituminous Coal & HSD).

Fixed Carbon	48.3%
Volatile Matter	29.1%
Ash	12.1%
Total Moisture	10.0%
Total Sulphur	0.53%
Gross Calorific Value	6300kcal/kg

Table 8. Coal Consumption (Rated Load).

Each unit per day:	1200 MT
Total for 2 unit per day:	2400 MT
Annual Consumption (70% P.F):	6,13,200 MT

Table 9. Ash Generation (Rated Load).

Each unit per day:	156 MT
Total for 2 units per day:	312 MT
Annual Consumption (70% P.F):	80,000 MT

Coal Consumption/Kwh: 0.4 Kg
Water Consumption Per Hour: 800-1200 MT

3.2. Environmental Impacts Surroundings of Barapukuria

The study was carried out to analyse the environmental impacts of coal mine and coal-based thermal power plant to the surrounding environment of Barapukuria, Dinajpur. The analyses of coal, water, soil and fly ash were carried out using standard sample testing methods. This study found that coal mining industry and coal-based thermal power plant have brought some environmental and socio-economic challenges to the adjacent areas such as soil, water and air pollution, subsidence of agricultural land and livelihood insecurity of inhabitants. The pH values, heavy metal, organic carbon and exchangeable cations of coal water treated in the farmland soil suggest that coal mining deteriorated the surrounding water and soil quality. The $SO_4(2-)$ concentration in water samples was beyond the range of World Health Organisation standard. Some physicochemical properties such as pH, conductivity, moisture content, bulk density, unburned carbon content, specific gravity, water holding capacity, liquid and plastic limit were investigated on coal fly ash of Barapukuria thermal power plant. Air quality data provided by the Barapukuria Coal Mining Company Limited were contradictory with the result of interview with the miners and local inhabitants. However, coal potentially contributes to the development of economy of Bangladesh but coal mining deteriorates the environment by polluting air, water and soil.

4. Recommendation

Recent signing of coal -based power station construction agreement has raised issues regarding environmental impacts such a power plant in ecologically sensitive area besides world biggest mangrove forest, Sundarban. The way of Bangladesh economy is developing there is urgent need of sustainable development.

Bangladesh has many renewable resources. If we properly use of this resources, then it can fulfil most of the electrical demand in Bangladesh. So, we should emphasis on renewable energy. If it is not enough to fulfil the electrical demand of Bangladesh, then we can go for clean coal technology to meet the existing demand of electricity.

4.1. Renewable Energy

Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides and geothermal heat. Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources. To prevent the harmful effects of fossil fuel burning there is no way but use various forms of renewable energy. [8]

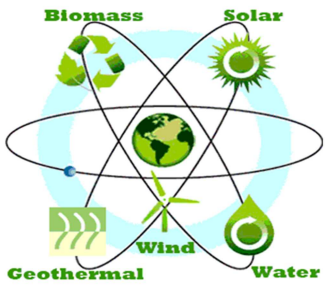

Figure 3. Renewable energy resources.

The movement of wind and water, the heat and light of the sun, the carbohydrates in plants, and the warmth in the Earth—all are energy sources that can supply our needs in a sustainable way. A variety of methods are used to convert these renewable resources into electricity.

Solar energy—power from the sun is a vast and inexhaustible resource that can supply a significant portion of our electricity needs. A range of technologies is used to convert the sun's energy into electricity, including solar collectors and photovoltaic panels.

Wind turbines harness air currents and convert them to emissions-free power. It is one of the fastest growing renewable technologies and has the potential to provide a significant portion of our electricity needs.

Using dams to exploit the movement of water for electricity, known as hydroelectric power.

The power of moving water is obvious to anyone who has stood amidst breaking waves or struggled to swim against a river's current. New technologies enable us to harness the might of rivers, tides, and waves for electricity.

Nuclear power is "clean" from an emissions standpoint—nuclear power plants produce no air pollution or global warming emissions when they operate—but its long-term role in combatting climate change depends on overcoming economic and safety hurdles.

Renewable energy has the potential to reduce pollution, slow global warming, create new industries and jobs, and move Bangladesh toward a cleaner, healthier energy future.

Physical Perspective of Renewable Energy in Bangladesh:

Various renewable sources such as solar, tidal, wind and biomass can be effectively used in Bangladesh. Solar energy is the free source of energy in our country and solar energy has been used in many household and industrial activities in Bangladesh. Some organizations have installed low capacity wind turbines, for battery charging in the coastal regions of Bangladesh. Micro Hydro Power Plants can be installed in the hilly regions. Only Hydro power ant —karnaphuli hydropower plant situated in kaptai with generating capacity of 230MW. It has 7 Units. Biomass is the fourth largest source of energy worldwide and provides basic energy requirements for cooking and heating of rural households in developing countries like Bangladesh. [9]

Renewable energy replaces conventional fuels in four distinct areas: electricity, hot water or space heating, motor fuels, and rural (off-grid) energy services. So, it is exigent to replace conventional fuels to renewable energy in Bangladesh.

4.2. Clean Coal Technology (Gasification)

Gasification is a key fundamental baseline technology for converting coal to anything other than electrons and can potentially be competitive even there. For example, gasification is the key conversion step for converting coal to H_2, SNG, liquid fuels, and the capture of CO_2 for sequestration.

Gasification is a conversion technology converts any carbon-containing material, coal for example, into synthesis gas. Carbon reacts with water in the form of steam and oxygen at relatively high pressure typically greater that 30 Bar and at temperatures typically reaching 1,500 K to produce raw synthesis gas or syngas, a mixture composed primarily of carbon monoxide and hydrogen and some minor by-products. The by-products are removed to produce a clean syngas that can be used as a fuel to generate electricity or steam. [10] [11].

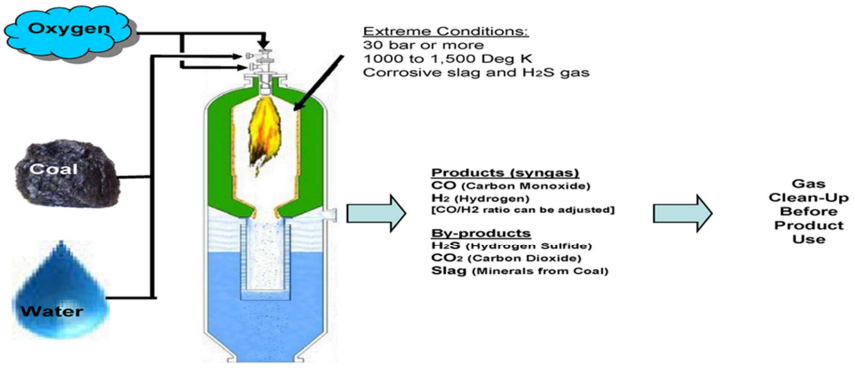

Figure 4. Gasification process basics.

Benefits of Gasification

a) Safety: No personnel required to work underground

b) Environmental: [12]

1. Ash is left underground.
2. CO_2 can easily be captured and re-stored.
3. Reduced SO_2, NO_2, methane, and Hg emissions.

c) Economic: [13]

1. Deep, un-mineable coal can be effectively exploited as new source of energy

2. The process may be significantly cheaper than that for natural gas
3. CO_2 capture can provide carbon credits

5. Result and Discussion

Barapukuria is the only natural coalmine reserve in Bangladesh that is in operation. In this study, an attempt was taken to conduct environmental impact assessment of Barapukuria thermal power and coal mining project through environmental, socio-economical and meteorological study. The analysis showed that, the Mn concentration was found in the satisfactory range. The pH was found slightly alkaline and surface water was bacteria contaminated. SO_4^{2-} concentration was in the range of WHO standard. Calculated SOx loading was almost same of monitored emission. Corresponding estimated concentration of SOx was in acceptable range, which may not bring any matter of concern. In the study, an attempt was also made to evaluate the health impacts of SPM (suspended particulate matter) emitted from the combustion of coal in the power plant. The socio-economic condition was also considered a dominating factor. In general, this study includes comprehensive baseline data for decision makers to evaluate the feasibility of coal power industry at Barapukuria and the coalmine itself.

Bangladesh with high population density needs a clean energy mechanism. Because of Bangladesh being densely populated country pollutants emitted by the use of dirty fuels especially like coal will endanger the lives of human being, animal and plants. It can easily spread many incurable dieses amass. We are still a developing country with poor generation of power. To go further ahead economically and financially huge power is to be generated. It can easily anticipate that lifecycle, animal, plant, human lives, ecosystem, environment, rivers, canals, creeks all will be jeopardized with the use of fossil fuel based power generation. So, power is vital but not at the cost of lives. So are to produce clean energy to satisfy all the requirements**.** Our Govt. should aware about the Gasification process instead of directly use of coal. In this Circumstances, we should emphasize about the renewable energy to fulfill our electrical demand.

References

[1] http://www.eschooltoday.com/energy/kinds-of-energy/what-is-electrical-energy.html

[2] http://www.mpoweruk.com/fossil_fuels.htm

[3] http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=5&Itemid=6

[4] http://archive.dhakatribune.com/environment/2013/aug/18/8-coal-based-power-plants-still-pipeline

[5] https://www.worldcoal.org/coal/what-coal

[6] http://geology.com/rocks/coal.shtml

[7] http://www.sourcewatch.org/index.php/Environmental_impacts_of_coal

[8] http://extension.psu.edu/natural-resources/energy/what

[9] https://www.researchgate.net/publication/224133535_Renewable_energy_scenario_of_Bangladesh_Physical_perspective

[10] https://energy.gov/fe/science-innovation/clean-coal-research/gasification

[11] http://www.world-nuclear.org/information-library/energy-and-the-environment/clean-coal-technologies.aspx

[12] http://www.gasification-syngas.org/applications/environmental-benefits-of-gasification/

[13] http://www.gasification-syngas.org/applications/economic-benefits-of-gasification/

Biography

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