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Burning for Development:

A Case Study on Socioeconomic, Environmental, & Climate Change Impacts of the Barapukuria Coal Plant

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ABSTRACT

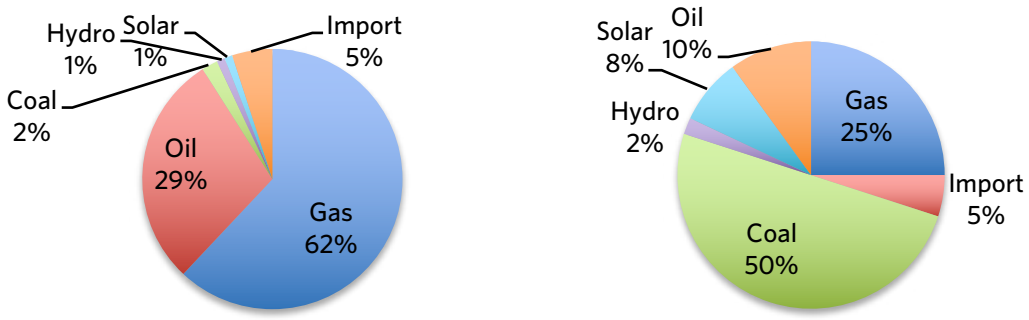
Bangladesh is about to embark on a major transformation of its energy system. To meet the growing energy demand, the government plans to increase coal-fired power generation from its current 2% to 50% of the country's total mix by 2041. As we look towards a development future with increased coal, we ask what will be the socioeconomic, environmental, and distributional impacts of this policy? This paper looks at Bangladesh's sole coal plant in Barapukuria at present, financed by China, in order to make an inference on the policy's impacts and draw lessons for the future. The paper presents initial estimates of key aspects of power generation: financing, employment, socio-economic, and environmental impacts of the Barapukuria coal plant. Using these findings the paper seeks to answer the pressing question: if we are looking at a 25 fold increase in the share of coal power generation in the next decades, **what** should the different stakeholders expect in terms of a) impacts, focusing not only on aggregate impacts but the relative distribution of these impacts, and b) **policies** governing these impacts on ground?

Background

Bangladesh is projected to grow its yearly energy-use by 6% on average for the next decade. The country is hoping to almost triple its power generation by 2030 (Power System Master Plan, 2016). This is not surprising given the changes in Bangladesh's economy over the past decade, with real GDP (Gross Domestic Product) growth averaging 6.2% year-on-year. The size of the economy nearly tripled and real GDP per capita increased by over 80% over this short time. Since 2016 the GDP growth rate has accelerated to over 7% driven by a double-digit growth in manufacturing and construction sectors (Bangladesh Development Update, 2018). The government is committed to continue on this path and is anticipating a change in the country's categorization from a "Least Development Country" (LDC) to a "Developing Country" by 2024 under the United Nations Department of Economic and Social Affairs (DESA) categorization (forthcoming Committee for Development Policy CDP Review, March 2018 Press Release). However, despite recent progress, Bangladesh still has a high rate of poverty and faces major challenges in infrastructure, particularly in the power sector. A recent World Economic Forum comparison of infrastructure among developing Asian countries ranks Bangladesh second to last (Schwab, 2017). A 2013 World Bank study estimates that Bangladesh will need $7-10 billion a year for infrastructure financing over the next decade (Andres et al., 2013).

In the power sector Bangladesh fares even worse. It has one of the lowest per capita consumption of electricity in the world as measured by the Energy Development Index (EDI) developed by the International Energy Agency (IEA). The low EDI score arises from low household-level access to electricity, low energy-use in the public sector and in production, as it is still an agrarian economy. In the latest Poverty Reduction Strategy Paper (PRSP) and Power System Master Plan (2016) the government outlines its plan to increase access to electricity and to grow the economy by expanding its heavy manufacturing sector, which is energy-intensive (PRSP, 2015). Currently most of the power is from domestic gas, but in the early 2000s the government announced that the country is at risk of running out of gas reserves by 2025, so the new policy is to switch to coal as the main energy source since there are coal reserves (Scaling Up Renewable Energy, 2015). To meet its growing energy needs, Bangladesh's energy policy is to increase coal's share in the total energy mix from 2% to 50% by 2041 as shown in Figure 1.

Figure 1: Current Energy Mix versus the 2041 Government Plan



Source: Power Sector Master Plan, Targets Scaling Up Renewable Energy in Low Income Countries (SREP) Investment Plan for Bangladesh, 2015

The government is planning to finance this frenzy of new power plants construction partly through the usual channels of foreign loans. Because of budget limitations, immaturity of financial markets, and relative higher cost of capital domestically, the availability of long term financing is limited within the country. Thus, Bangladesh finances most of its infrastructure investments through multilateral and bilateral loans. Though infrastructure funding has traditionally been dominated by Western banks, following the recent financial crisis many developing countries are increasingly attracting financing from newly emerging Asian sources, particularly China.

China has become one of Bangladesh's main development partners in recent years. Chinese companies and individuals are now offering assistance in developing the information and communication technology industry, power sector, river management, and industrial

zones in Bangladesh (Basu, 2017). Recently Bangladesh and China signed a Memorandum of Understanding on strengthening investment and production capacity cooperation, with Bangladesh set to receive $24.45 billion in bilateral assistance for 34 projects and programs (Byron and Rahman, 2016). And since last year China has become Bangladesh's biggest energy partner (Siddique, 2016).

Most notably, Bangladesh is looking to China's Export Import Bank to finance two of its largest coal plants, namely the Moheshkhali and Patuakhali coal plants, both at 1320MW capacity. Currently Bangladesh has only one coal plant and coal mine in Barapukuria, both of which were financed through a credit line with China's Import Export Bank. The construction was undertaken by a Chinese company, Harbin Electric International Company Limited (henceforth referred to as Harbin Electric), which is also in charge of operating the mine and plant jointly with the Bangladesh government for the next five years. As Bangladesh plans to dramatically increase the share of coal in its power sector, a case study on its sole coal plant could be used to gauge potential impacts of the government's coal intensive national policy in the coming decades. It also sheds a light on how key players, such as the investor and borrowing government, can regulate the impacts of these projects.

The research is presented in the following manner: section 1 is an overview of the plant and the key players involved. Section 2 describes the methodology and gives details on the key aspects considered. Section 3 summarizes the findings under each variable and identifies who are impacted for each. Section 4 reviews the social and environmental policies governing the investment, ending with policy recommendations.

Overview of the power plant

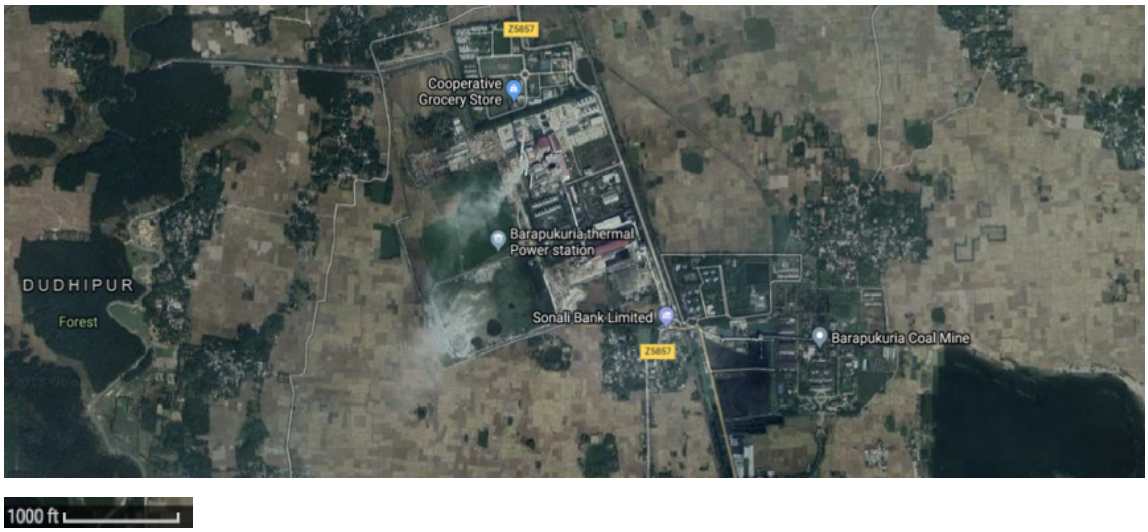
Barapukuria power plant is located in the northeastern part of Bangladesh, in Dinajpur district as shown in Figure 2. The power plant and adjoining mine are both financed by China's Export Import bank (90%) through a credit line and the government of Bangladesh (10%). The power plant started operation in 2006, and the expansion completed in 2016. The mine started operation in 2010 and produces around 1 million tones of coal yearly, of which over 80% is used for the power plant; the rest is sold to brick kilns and used for other domestic industries. Figure 3 is a Google map view of the area and shows that the plant and mine are next to each other. What is more difficult to discern from the image is that the area is completely enclosed with very high walls, around 20 feet, and is heavily guarded. The Bangladesh army and border guard are both deployed there. To visit the area one needs high level of clearance which is almost impossible to obtain unless through top government officials.

Figure 2: Barapukuria, Dinajpur District.

Source: Dinajpur visitor information website; retrieved from http://dinajpur.amardesh.com/

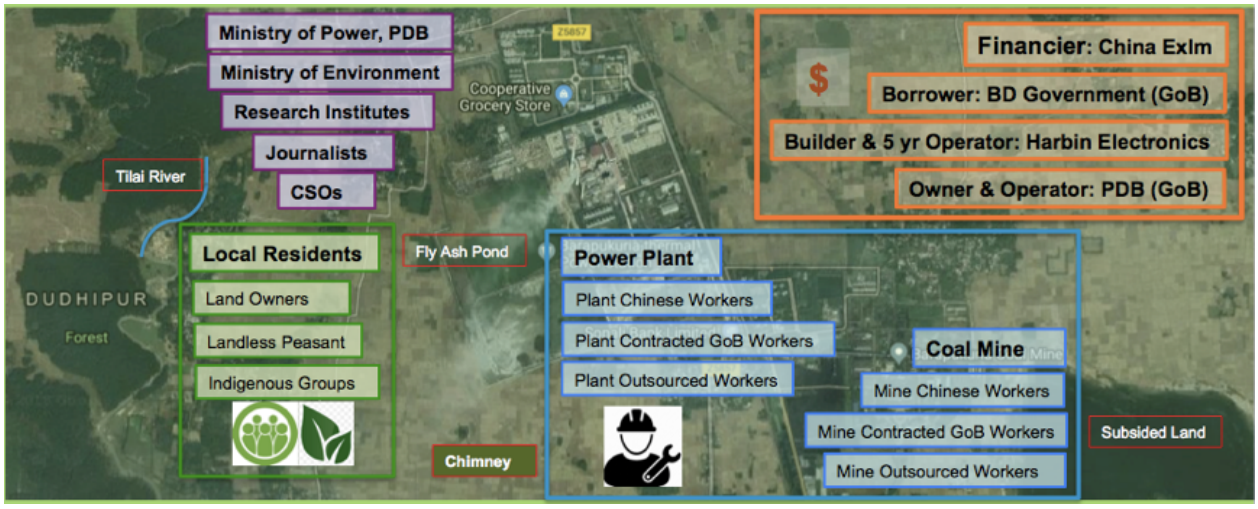
This situation arose after public backlash in 2006 against a proposed mine expansion, which was ultimately stalled. The protests were covered globally by leading news agencies such as Al Jazeera because of the brutality of government response. At least three persons were killed and 70 others injured as police and Border Guard Bangladesh (BGB) opened fire on people protesting in the neighboring Phulbari (Four Killed, 2006). In this backdrop it becomes crucial to talk to communities living in the vicinity of the power plant and hear their concerns regarding increased coal power generation. It must be mentioned here that due to the proximity of the plant and the mine and their starting date of operation, some of their impacts were difficult to separate in my conversations with impacted communities, particularly with regards to land acquisition and relocation.

Figure 3: Google map view of the Barapukuria coal plant and mine



Given these concerns over just one plant it is imperative to assess impacts of coal power generation under the new policy with respect to the **five key** aspects identified—financing, employment, other socioeconomic aspects, environment and climate change. If we are looking at over 25 fold increase in the next decades, **what** should the government, the financiers, and relevant stakeholders expect in terms of **impacts**, and not just what but **who** will be impacted most and in what ways? To help tease out these aspects, the key players involved are shown in Figure 4 below.

Figure 4: Key players



1. Financing: The Bangladesh government (referred to as GoB in Figure 4) borrowed 90% of the construction cost from China Export Import Banks, henceforth referred to as China ExIm, through a credit line. Power Development Board (PDB)— the power generation and distribution entity under the Ministry of Power, Energy, and Mineral Resources (MoPEMR)— is the owner and operator of the plant. Information on financing was acquired from the ministry and the plant.

2. Employment: The coal power plant employ three categories of workers: direct employees of PDB, the employees of Harbin, and the third-party contracted workers for construction purposes, referred to as 'civil work' in official documents.

3. Socioeconomic Impacts: Impacted local communities include deed-holding land-owners, peasants, and marginalized communities whose livelihoods and source of income were changed as a result of the power plant. Local non-governmental organizations (NGO), local politicians, and journalists play a key role in recording and moderating socioeconomic impacts.

4. Environmental Impacts: The coal plant's impact on land, water, and air are also experienced by the local community groups identified above. Ministry of Environment, NGOs, environmental, academic, and research institutes record some of the impacts.

5. Climate change impact: The Ministry of Environment estimates net greenhouse gas emission and oversee steps to minimize net emissions from the plant.

Methodology

Following the 2011 case study on the Marlin Mine by Zarsky and Stanley, and the 2013 study Chinese Mining in Latin America by Irwin and Gallagher, the methodology for this work was to first identify key impacts of coal power plant, then identifying the groups who are most impacted or involved in each aspect. The methodology for gathering the necessary information was to first contact key players involved with the power plant along the 5 key aspects. They are listed in Table 1 below.

Table 1: Methodology: Groups contacted and type of information gathered

Groups Providing Information	Type of Information
Ministry of Power, Energy, and Mineral Resources	Financing-related information: -Financial statements -Terms of loan agreement -Development Project Proposal
Power Development Board (PDB)	Employment-related information: -Wages -Terms of employment
Employees PDB	
Ministry of Environment	Environment-related information: -EIA -Studies on environmental impacts - Experiences of environmental changes
Research Institutes	
Communities	Socioeconomic Information: -SIA, Resettlement information -Reports on economic impacts - Experiences related to: compensation, access to land, changes in job situation, availability of power
Journalists	
NGOs	

To get documents on finance, operations, and access to workers I spoke to PDB and the MoPEMR. To get information and data on environmental and climate change impacts I went to the Ministry of Environment for the Environmental Impact Assessment (EIA) for the power plant. I also contacted universities, research institutes, journalists, and environmental groups for relevant studies. Environmental groups and journalists put me in touch with impacted local communities and gave me contact information of individuals who were able and willing to talk. To get information on social impact such as resettlement, health issues, and changes in access to resources, I spoke to local NGOs and local rights groups who work on these issues. I was unable to obtain a Social Impact Assessment (SIA) for the power plant, but some of the information pertaining to social impacts was included in the Development Project Proposal (DPP). I also spoke to journalists for information on social impacts and protests. After individuals were identified from journalists, CSOs, and the PDB, a series of unofficial meetings were organized with some of the impacted communities and employees.

These groups were selected not only because of their connection to the plant and the plant's impacts but also because they are trusted authorities on the aspects studied (journalists, research groups, human rights organizations, and environmental groups). They represent the range of positions on the key impacts and include stakeholders who stand to gain the most and lose the most from the power plant. Because the spectrum of positions on these 5 aspects were already identified from reviewing studies, reports, and news articles, I spoke to people on opposite ends in order to learn about the specifics on the issues and the specifics of their experiences.

To examine the distributional impacts of employment generated by the plant, I looked at the number of jobs created nationally and if there are foreign companies or employees involved, and if the employees are from the local communities. In other words I tried to determine who are the people employed by the plant. Next I examined the type of job created by the plant, if they are full time or part time and terms of employment. To examine potential indirect jobs created by the plant I looked at the national content of the inputs of the plant such as examining how much of the machines used to build and operate the plant are nationally made.

I also considered the potential of indirect employment and benefits created through revenue to the government and domestic companies, and subsequent investment in the economy through public spending and job creation. It was thus useful to examine if there is any royalty paid to the government, if there are duties, and so on. I examined if the government or Bangladeshi investors own shares in the company; does the government provide special tax allowances to the company; and if the energy is sold at a price guaranteed by the government and if there are subsidies involved. In addition, I examined if price projections for different energy sources are included in the project proposal, as they help determine the revenue and profits of the company over time and how much of that could indirectly benefit people through government revenue and through local and national public spending.

To determine the distributional aspect from the plants' environmental and social impacts I examined if the company, financial institutions or the state had a compensation and relocation plan. Did those relocated find alternate livelihood options? Did it lead to changes in access to services such as schools and hospitals? Do the people who have lost access to resources for example grazing land, water-bodies for fishing or irrigation have adequate alternatives? Have there been any changes in the underground water level, drainage system, or stream-flow of a nearby river?

Central to distributional impacts of direct land-use in Bangladesh is the question of how the land was acquired; were there any land disputes, any evidence of force used by the company to acquire the land or any other discrepancies in the land acquisition process and was the plant built on indigenous land? Indigenous and other marginalized communities have tenuous land-ownership documentation and are therefore vulnerable to forced eviction. To assess environmental risks I examined the following questions: did the construction create pollution from waste dumped on the roadside or in nearby water-bodies? Is the operation of the plant itself causing pollution? In order to assess risks to the plants as well as the communities I looked at the risk of land subsidence, storms, and flooding. Details on the type of information collected and sources are included in the Appendix.

Key Findings:

Table 2 lists the key players impacted and the overview for each variable. The main issues are summarized for the five variables, highlighting different impacted groups. The details are given in the rest of this section.

Table 2: Key players and findings for each variable

Variables	Key Players	Overview
1. Financing	Cost: construction $656m; operation and maintenance $4.76 m/year Financing: 13.11%	
	i. Bangladesh Government: PBD	borrower, owner, and operator
	ii. China ExIm	financier
	iii. Harbin Electric	builder and co-operator for 5 years
	iv. China Chamber of Commerce	exporter of parts
2. Employment	1346 people for construction (over 6 years), 586 for operation.	
	i. PDB employees	Government contract and wages
	ii. Harbin employees	34.2% of employee: mainly engineers
	iii. Outsourced workers	construction, land development
3. Socioeconomic Impact	**Land** 300 acres (acquisition cost $12.96 million or 2.06% of total cost)	
	Title-holding land owner	% compensated or relocated unknown
	Non-title holding land owners	not compensated
	Farmers	change in access to land
	Indigenous communities	Santal community mainly
	Health impacts	workers, community
4. Environmental Impact	**Water**: Plant requires 2400 metric tons water per day	
	Surrounding community	water depletion in 15 villages
	Community using pond	coal ash deposit
	Air: Co-pollutants (SO_x and NO_2) emission were found by the PDB to be within limits set by the Ministry of Environment.	
	Community	through chimney smoke
Climate Change	525MW power plant; GHG (subcritical): 4281669 tons CO_2 per year	

1. Financing:

Overview: The Bangladesh government borrowed 90% of the $656 million that was needed for construction over 6 years from China Export Import Banks, or China ExIm, as part of a credit line, with a repayment period of 13 years and 13.11% financing cost, of which interest rate constituted 3.99%, management fee 1.50%, commitment fee 1%, and insurance fee 6.62%. The plant was built by Harbin Electric, who are operating the plant for the first five years PDB. Yearly cost of operation and maintenance is $4.76 million at 80% capacity. All parts and machineries, constituting 60% of the construction cost, were imported from China Chamber of Commerce for Import and Export of Machinery and Electronic Products (Barapukuria Coal Powered Thermal Power Station DPP, 2013).

Main issues highlighting different impacted groups:

1) *Government of Bangladesh (GoB) finds a willing financier in China ExIm bank*:

Since the discovery of coal in the early 1980s, the mine and subsequent plant had been on the agenda of the Bangladesh government. In addition to a preference for gas, the lack of availability of financing, necessary equipment, and technical know-how pushed back the government plans for years. The rise of China's and other Asian countries' financing capacities coincided with Bangladesh's increased demand for energy, a demand that intensified as the country braces itself to run out of gas reserves, its main power source. Though China is reducing its domestic production of coal-sourced power, globally it is a top financier for coal power generation and top exporter

of coal production parts. These factors led to the GoB's decision to pursue coal, and to look to China not just as its main financier, but as the builder of the plant and provider of necessary production inputs. GoB benefits from this financing 'package' that includes machinery and skilled workers from China.

Development banks have recently shifted away from power generation from fossil fuel towards renewable energy, transmissions, efficiency investments, conducting feasibility studies, drawing up national energy plans with the ministries, and conducting environmental and social impact assessment for various energy sector projects, including the aforementioned coal mine expansion. For the Bangladesh government it has been difficult to find a co-financier for the Barapukuria coalmine and power plant, except through private sector and Asian Export Import banks. Similar to the financing through a credit line for Barapukuria, the financing for other large-scale proposed coal plants will be through credit lines from the governments of China, India, and Malaysia, as shown in Table 3 (Giant Coal, 2014). The differences between the operational principles of the different financing groups: private, state, and multilateral development bank (MDB) with respect to social and environmental impacts are discussed later. In a sense bilateral lending is performing a function that MDBs traditionally used to in Bangladesh. MDBs now function in alternate (e.g. renewable power generation) and complementary (e.g. feasibility study of fossil fuel projects) space alongside the new financing sources. Thus there is demand from the borrowing government for the type of projects Chinese policy banks are financing, as well as a preference for the financing terms offered.

Table 3: List of proposed coal projects in Bangladesh

Location	Financing Partner	Size (MW)
Khulna	Orion Group (private)	565
Maowa	Orion Group	522
Char Balakia	Orion Group	635
Char Balakia	Orion Group	282
Chittagong Gohira	Orion Group	612
Chittagong Bashkhali	S. Alam Group	612
Chittagong Bashkhali	Military Tools Factory (state owned)	600
Chittagong	Bangladesh Steel Re-rolling Mill (state owned)	150
Munshiganj	Electricity Generation Company, Bangladesh	600
Rampal	Bangladesh, India Export Import Bank	1320
Moheshkhali	Malaysia, China Export Import Bank	1320
Patuakhli	China Export Import Bank	1320

Source: News article *Giant Coal* Dhaka Tribune (2014, August 13).

2) *Potential vested interest groups within lending and borrowing governments*: Minutes from a meeting between the PDB and Ministry of Finance officials was obtained that hinted at rent-capturing motivations from specific entities under both government institutions. The hand-written minutes from the internal meeting records allegations that some Bangladeshi officials were bribed by specific Chinese companies, including Harbin Electric, that ended up winning tenders for power projects.

3) *Cost and Revenue, both direct and indirect, for the Bangladesh government*:

The Barapukuria plant and mine are state owned. PDB purchases coal from the mine at a fixed rate, which is updated every few years and fluctuates around the market price. The cost of production is currently around 6 taka or $0.074 per kWh. The selling price is on a scale depending on the intensity and type of customer (residential, commercial, light-use, heavy industry etc.) that follows a step-wise scale. The price ranges between 3.5-12.36 taka per kWh. After the loan repayment period of 13 years, the revenue generated go to PDB, which is responsible for providing power to the country and is completely state-owned. PDB's financial reports are available on their website and reveal no profits, which is expected given the price controls and regular adjustments. The current tax rebate policy in place for coal power generation, described below, will impact the cost to the government, beyond just the PDB.

4) *Coal companies (involved in extraction, generation, manufacturer of factor-inputs)*:

The national coal policy since 2010 waived corporate tax for contractors or licensees to encourage coal mine exploration, development and marketing, as well as a rebate of import duty, tax and value added tax (VAT) on the import of machinery for use in coal mining to encourage investment in coal. These benefit domestic and foreign entities involved in coal mining and power generation. The cost to the government of this policy and revenue to the different (private, public, domestic, and foreign) entities involved in extraction, generation, and manufacturer of parts have not been included in the project documents.

2. Employment:

Overview: During the 6 year construction phase, a total of 146 people were employed, of which 34.2% (50 employees) were Chinese. The 96 Bangladeshis are government employees and their contract is in accordance with the government employment policy. In addition, 1200 people were outsourced for 'civil works' that involve construction and development of land. 'Operation' of the power plant requires 586 government employees under the PDB who are Bangladeshi; of this number about 70 are categorized as '1st class' employees, 104 as '2nd class', and 406 employees are categorized as 'below 2nd class' employees.

Main issues highlighting impacted groups:

1) *Government employees*: Government jobs are extremely coveted because of the favorable pay scale and terms of employment. The employees interviewed were very satisfied with the work, and among the local communities a prevalent wish was for more people to have access to these jobs. However a common complaint from labor rights activists was that these government jobs are given to people from other parts of the country or to those with connections to government and the ability to buy influence.

2) *Lack of work for local population*: The PDB officials interviewed said around half of employees in the power plant are from the local area of Barapukuria. This is following a recent policy that 50% of the power plant employees have to be local. From group conversations with the PDB employees it seemed that lower paying jobs (below '2nd class') went to those who are local, but most of the higher pay-grade employees and officials did not. The lower paying jobs include cleaners and messengers.

The latest census shows that more than 43% of persons aged 7 years and older in the area are not able to read and write; nearly 46% had attained some form of primary education; and few had a secondary or higher secondary qualification (Bangladesh Bureau of Statistics, 2011). Given the average qualification of the area, there is local demand for work that is termed '2nd class or lower' in the government categorization. '2nd class' employees need to have completed 10th grade or secondary school, 'below 2nd class' employees do not need to complete 10th grade. It is mainly in this category that local communities may find work at the plant, which is why land development and construction work is a key source of employment.

3) *System of outsourcing civil works*: One major source of employment for local communities is 'civil works' or construction and development of land. The construction of the power plant happened in phases, and involved roads and highways being built or upgraded to support the heavier traffic and cargo loads. However all government 'civil work' for the plant and mine were outsourced through a tendering process. The PDB officials interviewed said they have no control over who is hired. In fact, for the power plant the responsibility of hiring the construction company was undertaken by Harbin Electric. I was unable to get any documents from Harbin Electric or talk to their employees regarding the outsourcing process.

4) *Community mobilization*: Local community members said they were sometimes hired if the tender for construction went to a company that hired locally, but at other times, people from other regions were brought in for construction work. Given that this is outsourced, the government is not able to note down local community members for repeated engagement. The demand of the community is that the construction work should be given to those whose livelihoods were impacted as a result of the loss of agricultural land on which power plant and coal mine were built. This has lead to repeated protests and strikes since the construction first started. Local activists interviewed stated that these protests led to the 50% requirement of local community members for PDB jobs. This points to a lack of channel of communication between PDB and community members. The activists interviewed stated that these protests, despite being inconvenient and disruptive to their daily lives, have been the only way to get authorities to listen to their concerns and in some instances enact change.

5) *Indirect jobs*: Indirect jobs— such as from manufacturing coal plant machineries or cement factory— that are generated from con-

struction of new power plants are also potential sources employment. However machineries and other inputs are all imported. This constituted a major part (60%) of the construction cost. The only local inputs are construction material such cement, brick, steel for buildings, constituting 6.56% of total costs. The lack of skilled engineers and employees in Bangladesh was the reason stated for hiring a considerable share (34%) of Chinese employees. This means a potential loss of indirect income generated through multiplier effects in Bangladesh's economy.

SOCIOECONOMIC IMPACTS

1. Access to land:

Overview: Land is the main income source for the majority of Bangladesh's population. Moreover, access to land is a key determinant of socioeconomic wellbeing as Bangladesh is land-constrained. For large projects, land acquisition is often a source of complication and delay for the government. In the case of Barapukuria power plant, the direct land used was 300 acres, which the government first acquired from titled landowners before starting the project.

Main issues highlighting impacted groups:

i) *Titled-holders*: Interviews with local journalists and community members indicate that landowners received compensation as per government policy. Compensation amount is decided according to classification as homestead land, agricultural land, or for business (e.g. stores) and market price determined by quality of soil, nearness to highways, river etc. as per government policy. Local community members have stated the price they received was fair and some thought it to be above the market price. The compensation was around $30864.2 per acre. There were no reports of undue pressure or force involved in the land acquisition process. This is in contrast to previous incidences reported of forceful eviction, pressure used to acquire the land, and other discrepancies around compensation in the land acquisition process of other large projects in Bangladesh.

ii) *Relocated families*: A number of families were relocated to a government plot of 30 acres, which was purchased by the government mainly due to the large amount of land acquired, and large number of people relocated, not just for the power plant but also for the coal mine, and more recently due to land subsidence resulting from mine activities. The 30 acres constitute only a tenth of the land on which the power plant was build, not counting the mine or subsided land area. The government plot was not sufficient for all the relocated families, and so not everyone could get access to the government plot. In the group discussion with the community members they stated some of those relocated are having difficulties settling in and finding work. This is not surprising given how important social ties are for accessing livelihood options and resources in Bangladesh.

iii) *Scope of Social Impact Assessment (SIA) and Management Plan:* The SIA for Barapukuria did not include non-title holders, sharecroppers, nor the indigenous communities whose access to the land was reduced in some ways due to the plant. The census indicates that approximately 9% of the surveyed households are from ethnic minority groups, with the Santal being the largest of these ethnic minority groups. Agriculture labor (mainly rice production) is an important source of livelihood and income for most farm, non-farm, and landless households in the area, but it is a particularly important source of income for ethnic minority households. Interviews with local activists revealed that many of the wage laborers in the fields who have been adversely affected by the plant and mine are from the minority Santal community. There is no special policy or practice at the mine or plant to employ impacted minority groups. The access to land deeds and the process of legalization of land ownership is extremely complex in Bangladesh. 80% of all court cases in the country are related to land and ownership disputes (Barkat and Roy, 2004). Marginalized communities, such as indigenous groups in the area, are often most disadvantaged in accessing titles. Those who were not titled landowners did not receive compensation from the government.

iv) *Indirect impacts*: Stores in the locality were not directly impacted since they are not on subsided land or on the area included in the project site, but have nonetheless suffered due to fewer customers from the loss of the communities who had to relocate due to the plant and mine. The majority of the workers in the mine and plant do not shop at these stores according the owners interviewed. The plant and mine area have their own shops inside the restricted compound. The PDB officials stated that this is due to security reasons

and language barrier faced by Chinese workers. The compound is completely closed off and is heavily guarded by armed forces, thus the store is not accessible to the community.

v) *Abutters*: The outcome of changes in property values located near the project site have been mixed. There has been no formal study but conversations revealed that the value of property near new roads and highways around the plant and mine has increased. In contrast there has been fall in value of areas that have experienced land subsidence or expect to experience land subsidence in the future.

2. Access to electricity and improved connectivity:

As recently as 2016 the area suffered from daily power outages. The local movement demanded that the government to prioritize the electricity produced for local use in the Dinajpur district. Since then there has been fewer power outages according to the community members interviewed, some of whom had been involved in initial protest. Moreover, as a result of the coal power plant, connectivity has improved because of the new roads and increased train service.

ENVIRONMENTAL IMPACTS

1. Water:

i) *Depletion of underground water:* The power plant requires 2400 metric tons per day of ground water. This has led to a severe crisis of ground water depletion. Local activists reported that people in 15 villages have suffered as a result. The average population in a village in that region is 1461 to give an idea of the number of people potentially impacted (Bangladesh Bureau of Statistics, 2011). The situation got so bad that after months of protests, last year the government built 8 overhead water tanks, that are filled from trucks bringing in water from outside the area and are partly financed from revenue from the power plant, according to the PDB officials interviewed. The cost of accessing the water is around 9 taka ($0.11) per month per person. Though this was not felt to be expensive, the community members interviewed proposed an alternative; it would make more sense for the power plant to purchase water from the overhead tanks, since the underground water is needed for irrigation, in addition to household use, and in the future with continued coal plant operation there may be further depletion. The communities, such as the Santals and poorer households, are most dependent on agriculture, and therefore on proper irrigation and access to water. They are thus disproportionately disadvantaged from water level depletion.

ii.) *Water pollution:* The environmental impact assessment (EIA) conducted by the environment ministry states that the wastewater produced by the plant is treated before being released in the Tilai river. Additionally it states that chemical and bacterial test of the water released is done every month. However a 2015 study found that hourly 9 cubic meter of industrial wastewater from the plant is discharged directly into the Tilai River without treatment. The river is around 5km in length but is connected to other tributaries and seeps into the underground water. In addition, the power plant contains two ash ponds. The study found that the ash pond contains harmful heavy metals such as boron (B), arsenic (As) and mercury (Hg), which could seep into underground water sources over time (Hossain et al., 2015). Therefore, ground water could get polluted and could become unsuitable for domestic use. The findings support the experience of local community members interviewed, who said that the Tilai river has been polluted since the coalmine and power plant started operations. There were no complaints however of waste disposal in the river during the construction phase of the plant.

iii) *Health concerns:* A leading daily reported two cases of skin issues allegedly arising from use of the water from Tilai river, where the power plant emits wastewater, but the local doctor disagreed with the claim stating that it is not related to water use (Barapukuria Plant, 2016). The PDB authorities interviewed felt that these complaints were an attempt to get PDB to pay for treatment costs for skin issues that are unrelated to the plant's activities. This suggests that there is a mutual lack of trust between the authorities and the community around evaluating impacts of the power plant, making third party assessments such as from universities and research institutes even more important.

2. Air:

i) *Government measurements*: Coal-based power plants emit carbon dioxide (CO_2), sulphur oxide (SO_x), nitrogen oxide (NO_x), and suspended particulate matter (PM) through the chimneys (Pokale 2012). Though the SO_2 and NO_x levels were found to be within allowed range, particulate matter less than 10 microns in equivalent aerodynamic diameter (PM10) levels in areas around the coal mine were found to be near the upper bounds of Bangladesh Environmental Standards (BES) levels from the government conducted EIA.

ii) *Independent Measurements*: The social activists interviewed stated that they are suspicious of measurements done by government officials. An independent study undertaken by Rajshahi University on air quality due to the coal mine's and plant's activities had slight variations in results from EIA results, particularly for the mine. The study did not include independent measurements of air quality inside the mine, but reported miners' complaints on air quality and related health issues, which raises further questions about the official measurements. Thus the lead researcher in the team recommended that the government allow third party air quality monitoring (Masud et al., 2013).

iii) *Protests from communities*: Local people organized mass protest when the third and last chimney for the power plant was being constructed in 2017. The activists interviewed said the protests resulted in the new chimney height being taller than others. This disperses the emissions over a larger area, such that the pollutants are less concentrated and the air quality of nearby areas is better. This is another instance of a lack of effective channel of communication between impacted communities and the PDB.

3. GHG emission

PDB reported that 40,000 trees of various species have been planted to offset some of the GHG emission from the power plant. But this would at most sequester 900 tons a year, whereas total emission from the plant is estimated to be around 4281669 tons a year, given the size of the power plant and technology— using emission factors from MIT's 2007 Future of Coal study following the method used in Gallagher's 2016 policy brief (Future of Coal, 2007; Gallagher, 2016).

Policies governing social and environmental impacts

The above findings point to several recurring issues over the life cycle of the project— beginning with the initial screening process that include specific requirements in terms of impact assessments; parameters around implementation that include steps to reduce negative impacts such as scope of compensation and resettlement or minimum chimney height and fly-ash deposit procedures; monitoring and evaluation process allowing third party assessments; a channel of communication with the affected communities that ensures a functional grievance mechanism system to reduce risks to the project from frequent protests that had resulted in such heavy-handed security measures in Barapukuria.

These issues summarized above are related to the policies governing social and environmental impacts of the investment and how well those policies are implemented. In the case of Barapukuria coal plant the relevant policies governing the project include the host country Bangladesh's policies and the financier China ExIm's policies. More generally, given the role of China as Bangladesh's main energy partner, China's policies on overseas investments are also relevant. The list of coal projects in Table 3 shows the growing importance of private finance, which are governed not only by the country's policies but can also be governed by the Equatorial Principles for signatories committed to reducing environmental and social risks. Thus the Principles can serve as a benchmark for environmental and social safeguard standards. The continued relevance of multilateral development banks (MDBs) in the power sector, such as through financing feasibility studies, and their historical role in financing power generation in Bangladesh make their safeguard policies a natural candidate to serve as a benchmark for international standards. This section provides a comparison of the relevant policies across these different entities, along with how they were implemented in Barapukuria.

Overview of the policies

The different policies considered here are those that touch on the key aspects discussed in previous sections with respect to Barapukuria coal plant. Specifically these include policies pertaining screening, scoping out the scale and parameters of impacts considered, specific requirements in terms of social and environmental impact assessments or management plan, health and safety requirements, resettlement plans, monitoring policies including provisions for or requirement of independent reviews, information disclosure and public consultation including frequency of consultation and setting up a channel of communication with affected parties. Information on every one of these policies could not be gathered for each of the five entities, namely: policies of GoB, China ExIm, China overseas investment, Asian Developnment Bank (ADB), and Equatorial Principles, but based on a review of what was available on their websites, including other project documents, a summary of the key aspects are presented here, noting where they explicitly differ from each other and how they compare to the experience of Barapukuria coal plant.

GoB:

Bangladesh is signatory of a number of environmental agreements such as United Nations Secretariat of the Convention on Biological Diversity (CBD); United Nations Convention to Combat Desertification (UNCCD); and United Nations Framework Convention on Climate Change (UNFCCC). The GoB has also adopted or amended existing legal provisions which include the Bangladesh Environmental Policy, Regulations, and Guidelines and the 1992 National Environmental Policy. In 1995 the Department of Environment updated the screening criteria to categorize projects and in 2009 "Right to Information Act" was enacted (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

The Department of Environment has set out **screening criteria** to categorize the projects into Green, Orange A, Orange B and Red (in order of increasing severity of impacts), which deterimes the level of EIA required. The screening is based on project type only, irrespective of its **scale** and **location**. Though Bangladesh has prescribed eight locations as Environmentally Critical Areas, they are not factored in screening. A full-scale **Environmental Impact Assessment** (EIA) is required for Orange B and Red Categories of projects. The EIA report has to incorporate 'Occupational and Community Health and Safety' aspects, 'Exclusions and Sensitivities' and 'Identification and Assessment of Alternatives' (to site, routes, process, raw materials) as part of mitigation measures (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

The Department of Environment (DoE) issues and updates **emission** and ambient **standards**, which are in general comparable to international standards. DoE recommends that a technical summary be prepared that includes **Environmental Management Plan** (EMP) as an outcome of the EIA. The EMP requires risk analyses when there is storage and handling of **hazardous** and **toxic** substances; 'Compensatory Afforestation' when more than 5 hectares of land is deforested; plans for '**Resettlement** and **Rehabilitation**' when more than 1000 people are displaced. The EMP includes an implementation schedule and monitoring requirements. The workplace or **occupational standards** are covered under the Factories Act.

EIA Guidelines for Industrial Projects recommend a Post-Project Monitoring Programme. The DoE is responsible for monitoring and making compliance reports available to the public. The guidelines recommend that a technical summary be prepared for the purpose of communication to public. There are no formal provisions to conduct **independent assessment** of EIA report or independent audit of approved projects. Though not required, **third party monitoring** is recommended through approved laboratories. Under DoE guidelines, **public consultation** and **participation**, fixed time frames for **prior disclosure** of EIA to the public, and **grievance mechanism** are not mandatory. (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011)

Asian Development Bank (ADB):

ADB's operational policies include three safeguard policies: the 1995 Involuntary Resettlement Policy; the 1998 Policy on Indigenous Peoples; and the 2002 Environment Policy. The project's **category** is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, **location**, **scale**, the sensitivity and the **magnitude** of its potential environmental impacts (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

ADB's **Environmental Assessment (EA)** is required to include occupational and community health and safety provisions, as well as exclusions and sensitivities. It precludes project activities that involve or are likely to result, directly or indirectly, in the degradation of **critical habitats**. The EA examines feasible alternatives to the project location, design, technology and components, environmental and social impacts. With regards to environmental **standards** the EA applies 'pollution prevention and control technologies and practices' consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety (EHS) Guidelines (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

ADB requires the preparation of an **environmental management plan** (EMP) that includes proposed mitigation measures so as to cayse **no significant harm to third parties**; environmental **monitoring** and **reporting requirements**; implementation **schedule**; cost estimates and performance indicators; and applies the **polluter pays principle**. EMP mentions safe and healthy working conditions, and prevention of accidents, injury, and disease for workers. It also requires preventive, and emergency response measures to avoid or minimize risks to the health and safety of local communities (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

For complex and sensitive projects, **independent advisory panels** during preparation and implementation of projects are used. **Monitoring** the effectiveness of EMP implementation is scheduled in the planning stage. Periodic **progress reports** covering monitoring results, development and implementation of corrective actions are publicly available. **Consultation** with affected people include all stakeholders, with particular attention to project-affected people and concerned NGOs and is conducted early in the project preparation (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

China ExIm:

Guidelines for Environmental and Social Impact Assessments of the China Export and Import Bank's Loan Projects were developed in 2007 in accordance with China's Environmental Impact Assessment (EIA) Law, Environmental Protection Law, Environmental Management for Construction Project Ordinance, and with reference to regulations and procedures for environmental and social assessments of other international financial organizations (Matisoff and Chan, 2008).

China Exim's 2007 guidelines explicitly require overseas projects to comply with host country laws unless host countries have **inadequate** environmental protection regimes, then Chinese or **international standards** are to be used. The guidelines also mentions social impacts, including land rights and **resettlement**, which other Chinese policy banks (except China Development Bank) have not explicitly included in their guidelines (Gallagher and Qi, 2018).

With respect to overseas projects, social and environmental **impact assessments** that meet the host country laws are required. China Exim bank states that it actively participates in environmental impact **monitoring** throughout the entire project cycle and reserves the right to cancel financing if environmental impacts are not adequately addressed (Matisoff and Chan, 2008).

China's overseas investment:

A 2018 report published by Gallagher and Qi outlines policies governing China's foreign direct investments. These include the 2017 Regulations on Outbound Investment and Business Activities of Private Enterprises pertaining to the following entities: National Development and Reform Commission (NDRC), Ministry of Commerce (MOFCOM), People's Bank of China (PBOC), Ministry of Foreign Affairs (MFA), and All-China Federation of Industry and Commerce (ACFIC); the 2013 Guidelines for Environmental Protection in Foreign Investment and Cooperation for MOFCOM, Ministry of Ecology and Environment, formerly the Ministry of Environmental Protection (MEP); and the 2013 MOFCOM/MEP Provisions on Regulating Competitive Behaviors in the Fields of Foreign Investment Cooperation.

The 2017 Regulations on Outbound Investment and Business Activities of Private Enterprises recommends that private firms undertake environmental impact assessments for their overseas construction and business operation; apply for environment related permits from the host country, or refer to standards of international or multilateral organization; develop contingency plans for environmental emergencies; reduce the emission of pollutants; and actively engage in ecological restoration (Gallagher and Qi, 2018).

Equatorial Principles:

Principle 1 requires **screening** and **categorizing** of proposed projects according to the **magnitude** and severity of anticipated impacts. Principle 2 requires project financiers to undertake **social** and **environmental assessment** addressing key environmental and social issues. Principle 3 requires the environmental assessment report to address baseline environmental and social conditions, follow **host country laws** and regulations; applicable international treaties and agreements; sustainable development and use of renewable natural resources; protection of human health, cultural properties, biodiversity, endangered species, and sensitive ecosystem. It also refers to **international standards**, treaties and declarations, and good practices. In instances where the laws and regulations of host countries are not comparable to international standards and good practices, it encourages the recipient governments to make necessary adjustments. The environmental assessment is required to address endangered species, **occupational health** and safety, impacts on **indigenous peoples** and communities. Principle 3 also requires consideration of feasible **alternatives** to the project. Alternatives or mitigation measures to avoid or minimize adverse impact are required to be incorporated in the project plan. Based on the Environmental Assessment, Principle 4 requires the financier to make agreements with their clients on how to mitigate, monitor and manage risks through a **Social Environment Management Plan**. Principle 5 requires the borrower to consult stakeholders and provide them with information on risks of the project. Principle 7 and Principle 9 mandates **independent monitoring** and **reporting** for sensitive projects over the period of the project's life (Environmental Impact Assessment: Bibiyana I and II Gas Power Project, 2011).

Application to Barapukuria

For this case study the most relevant set of policies are those of the host country. The summary of the policies above indicates that even when financiers have their own set of policies, the policies of the host countries play the key role in moderating the impacts of the project. It is important to note here that the policies of the host country will become even more important in the future as MDBs, including ADB, move to country or client systems, albeit with the condition of equivalency. However, the experience of Barapukuria shows that even when the financier has a condition of equivalency, in this case China ExIm, it may not be implemented for each project.

Screening:

The Barapukuria coal plant falls in the 'Red' category under GoB screening. The GoB policy does not take into consideration **scale** and **location** when screening projects. Though the DoE has Environmentally Critical Areas listed they are not factored into screening criteria. Moreover Environment Impact Assessment is only required for Categories Orange B and Red. This is different from the policies guiding ADB, Chinese Overseas Investment, and the Equatorial Principles.

Public Consultation and Grievance Mechanism:

The GoB guidelines does not require public consultation and participation, fixed time-frames for prior disclosure of EIA to the public, or grievance mechanism facility, differing from ADB's policies. The importance of an easily accessible grievance mechanism is especially important for projects like Barapukuria as indicated by the frequency of protests.

For the Barapukuria power plant community members and activists confirmed that there was prior public consultation, though potential risks such as water pollution or depletion were not mentioned. PDB official states the government has a clear policy for filing complaint with the PDB should issues arise. However the community has organized numerous protests that have been widely reported and thus documented since the beginning of the plant operation because they felt their complaints were ignored by the authorities. One of the activists interviewed has been arrested three times and in one instance had been severely beaten. As noted earlier, some of the protests has been around the mine and plans for its expansion.

For the coalmine, provisions have been made for grievance mechanism and any complaints made are available online. For the power plant, there is an online portal on the PDB website but not for individual projects. The process is outlined in its policies, and is practiced according PDB officials. However, activists have found that no action is taken even after following the proper procedure, which includes filling out the forms and complaining to authorities about breaches. This leaves the activists and some community members no alternative to staging protests, which have led to positive results in some instances, such as increased power availability in the locality; change in policy with respect to local employment; and increased chimney height in the power plant.

Environmental Management Plan (EMP):

An Environmental Management Plan (EMP) is required as an outcome of EIA and should include aspects such as risk analyses when there is storage and handling of hazardous and toxic substances. In the case of Barapukuria an EMP was completed and explicitly mentioned mitigating risks from the ash pond. But in reality, when community members raised complaints about the untreated ash pond nothing was done about it. The ADB policy follows a 'polluter pays' principle, which is not mentioned in the other policies examined here. For Barapukuria this would be relevant for the issues surrounding water depletion and pollution, which has resulted in surrounding communities needing to buy water.

Resettlement Policy:

Resettlement and Rehabilitation Plan under GoB policies is required when more than 1000 people are displaced. For GoB the scope of impacted individuals is not specified. So the plan included only those who are titleholders of the land on which the power plant was built. The government also compensated those whose land subsided due to coal extraction. Though GoB compensated and resettled

titleholders, they did not provide livelihood alternatives to all affected households, some of whom faced difficulties finding suitable alternatives. Bangladesh is land constrained and migrants to new locations often face difficulties and resistance from older inhabitants. ADB and Equatorial Principles specifically mentions indigenous communities and livelihood impacts, with the ADB policies being the most detailed in terms of the scope of indirect impacts considered.

Monitoring:

Community members and universities have recommended institutionalizing third party independent monitoring of air and water quality in Barapukuria. The Environmental Management Plan under GoB policy requires a monitoring plan and scheduling but independent audits or third party monitoring though recommended is not required. With respect to overseas projects China Exim bank's policy states that it will actively participate in environmental impact monitoring throughout the entire project cycle and reserves the right to cancel financing if environmental impacts are not adequately addressed. It was not possible to access China ExIm's reports for Barapukuria for this study.

Key Points and Policy Recommendation

The main points that stand out from this case study are summarized in this section including an assessment of the government policy and recommendations based on the findings.

Distributional impacts

It is important to note that different groups within a country or locality are affected differently from the power plants. Distinguishing these groups help understand public support for or resistance to a project and can help direct policy to reduce disproportionate negative impacts on specific groups.

Policies around resettlement/compensation: The financier in the case of Barapukuria had limited role to play due to adherence to host country policy despite China ExIm's and China's foreign investment policies which mention adherence to international standards. The Bangladesh government is in charge of decision-making and execution of acquiring land and coordinating relocation. The pushback against expanding the power plant was largely around further displacement. Thus, despite government reports of successful relocation, the experience of those displaced was negative enough to spark repeated protests.

Changes in Employment: The Barapukuria power plant and coalmine did not consider differences in the number and type of employment generated for all activities related to the project, since wage and benefits differ for employees of the power plant and workers who are from companies that are outsourced. The lack of job security for outsourced workers have caused mass protests in the power plant.

Changes in access to land-use and natural resources: The government report did not look into livelihood options for those with reduced access to land and water resources. Land acquisition process was clearly detailed for those with legal deeds to the land. The land was sold at market value. However there was no government report on the presence of indigenous population in the area, or follow-up on indigenous households that were relocated. Detailed social impact assessment should include impacts on marginalized communities such as indigenous communities, shareholders, non-title holder whose livelihoods depend on access to agricultural land and water availability. Going forward they can be given work at the plant or other projects in the area such as road expansion, and construction of embankment. The government does not provide details on the households who have been relocated. News reports mention families who have not received compensation as well as families who have been relocated as per government policy but are suffering given their lack of social network in the new area, which greatly influence livelihood options. The adequacy of the alternative settlement should also include measures such as changes in proximity to schools, hospitals etc. The land allotted by the government for relocation was a tenth of the land from which people were relocated for the plant, not counting the mine or subsided land.

Water bodies play a large role in providing nutrition to local population, since fish is a large part of the diet, and water is important for irrigation. Coal plants severely reduce access to water, increase pollution, and interrupts stream-flow/drainage. These aspects should

be incorporated when estimating socioeconomic impacts of a power plant. Water depletion was not addressed adequately in the EIA. Going forward assessment could include a 'polluter pays' principle, institutionalize third-party assessments especially for Category Red project, fixed frames for prior disclosure to the public. Though there was prior public consultation in Barapukuria's case, this is not a requirement for social impact assessment.

Environmental Impacts: The government regularly monitors air and water quality but the results have differed from those conducted by the environmental department in a nearby university. Universities in conjunction with non-governmental environmental institutions should formalize independent monitoring requirement for all power plants. Water pollution from wastewater from the power plant and from the ash pond are addressed in EIA but was not implemented properly. Though China ExIm policy states they conduct impact assessments these were not available. The GoB impact assessments were not available online but had to be acquired in person. Social and environmental impact assessments of both GoB and China ExIm should be made available online. Going forward MoE's EIA should to be amended to include third party monitoring, public consultation and participation, fixed time frames for prior disclosure of EIA to the public, and grievance mechanism.

Sustainability: Long term considerations

For a country that is still developing its energy infrastructure, a sustainable energy infrastructure development would be an opportunity for Bangladesh to get it right the first time, instead of risking stranded assets and other losses in the future. As such the final and perhaps most important question addressed in this paper is this: Is the government plan for 2041 at all compatible with a longer time horizon? We find that even if theoretically we could better safeguard and perfectly implement the risk reduction measures, the plan has a few glaring issues.

Considering longer timeline for Net Revenue:

The GoB does not consider price (of different energy sources) projection for the lifetime of power plant. The repayment period of the Barapukuria coal plant loan is ten years. At the end of ten years the cost of power generation from renewables will be comparable to the cost of coal. Since the period of operation of the power plant is much longer than the repayment period, a longer time period of at least 30 years should be considered in the financial analysis of the government. Bangladesh's price projections (levelized cost of electricity or LCOE) of different energy sources show that Solar PV will be cost competitive to coal by 2030 and will continue to fall in unit price making it more competitive relative to coal power generation, even with the less expensive subcritical technology deployed in Barapukuria. All relevant policies such as tax rebates for coal, government subsidies and price guarantee also need to be factored in for the lifetime period of the power plant.

Water depletion, water and air pollution:

The output from the Barapukuria coal plant currently constitutes 2% of the country's power generation. A 25 fold-increase will be needed to achieve the 50% coal target under the government plan for 2041. This would mean a massive jump in not only air and water pollution, but also of water depletion. The case study showed that water depletion and pollution would have a disproportionate impact on the most vulnerable populations in the area. A 25-fold increase in impact would lead to water-strain on potentially 375 villages in the country. That is a potential impact on 275,000 individuals, assuming a conservative average village size of a thousand. The plan did not account for the inevitable high cost of replacing this water for the impacted communities' daily use and irrigation, as lower-income households are more dependent on agricultural work. Water depletion and pollution would also impact the water level and thus the fish populations in surrounding water-bodies. The livelihoods and protein-source of the poorest communities in Bangladesh are heavily dependent on the availability of fresh water fish in common water bodies.

A 2016 report IRENA "True Cost of Fossil Fuels: Saving on the Externalities of Air Pollution and Climate Change" finds that a reduction in the share of fossil fuel by half would lead to a 33% fall in particulate matter (PM2.5) emissions that result in serious adverse effects on human health. In addition this would also reduce health complications arising from emissions of copollutants (air pollutants excluding GHG from burning fossil fuels) such as mono-nitrogen oxides (NO_x), sulphur dioxide (SO_2), ammonia (NH_3) and VOCs or volatile organic compounds (IRENA, 2016).

The exact cost calculations from water pollution, depletion, and from air pollution is beyond the scope of this study. These estimates involve the specific features of the power plants locations and estimates of at-risk populations with a timeline that goes beyond the lifespan of the power plants (Boyce, 2016). Bangladesh is one of the most densely populated countries with a population density of 1,115.62 people per square kilometer, the density can be assumed to increase over the next few decades. As such it is reasonable to expect the cost of pollution on the health of affected communities to be significant. The localized costs of untreated wastewater seeping into underground water and nearby water bodies and from untreated ash ponds are also beyond the scope of this study.

To give a ballpark figure of the cost of air pollution, we can refer to a number of studies that have placed monetary valuations on the air quality cobenefits obtained from reduced combustion of fossil fuels in regional and global contexts. Nemet et al. (2010) estimated an average cobenefit (benefits other than those from reducing GHG emission) of $49 per ton of CO_2 from 37 studies of air quality cobenefits from around the world. The U.S. National Academy of Sciences (2009) has calculated that premature deaths attributable to copollutant emissions from fossil fuel combustion impose a cost of $120 billion/year in the United States. A study by the Netherlands Environmental Assessment Agency find the cobenefits from a policy involving reduced GHG emissions would offset the policy's costs even without considering long term costs of climate change (Berk et al. 2006).

Greenhouse Gas Emissions:

The Intended Nationally Determined Contributions or INDC of Bangladesh with respect to mitigation consists of the following elements. Firstly, an unconditional contribution to reduce GHG emissions by 5% from the 2015 Business as Usual (BAU) levels by 2030 in the power, transport and industry sectors. Secondly, a conditional 15% reduction in GHG emissions from BAU levels by 2030 in the power, transport, and industry sectors, subject to "appropriate international support in the form of finance, investment, technology development and transfer, and capacity building" (INDC, 2015).

The current BAU emissions level considered above is low due to Bangladesh's current low energy-use intensity as well as the low emission-intensity from the high proportion of gas in the energy mix. However, the Power Systems Master Plan (PSMP) shows that both are set to increase in the coming decade. The 2015 book Global Green Growth provides a useful way to gauge variations in per capita CO_2 emissions level by decomposing the emissions per capita ratio into three component parts:

Emissions/population = (GDP/population) x (Q-BTUs/GDP) x (emissions/Q-BTU).

These three ratios provide measures of the following aspects:

1. Level of development: Measured by GDP/capita;

2. Energy intensity: Measured by Q-BTUs/GDP;

3. Emissions intensity: Measured by emissions/Q-BTU.

Table 4: Determinants of per capita CO_2 emissions level for Bangladesh, 2010: Level of development, energy intensity, and energy mix

Emission per capita (mt)	GDP/population	Q-BTUs/trillion dollars GDP	emissions/Q-BTU in million mt
0.38	$858.98	8.171	53.95 mmt

(Source: International Energy Statistics)

In the case of Bangladesh the decomposition in Table 4 shows that largest factor contributing to the low per capita emissions is the low per capita GDP. The emissions intensity is lower than that of most countries because the country's main energy source is natural gas. As the 2041 plan shows, the country is set to increase the share of coal. Furthermore, the low energy intensity level is in part a reflection of Bangladesh still being in the process of transitioning to a more energy-intensive manufacturing economic structure from the current structure, with a large portion of its economy dominated by rural agricultural activities that are less energy-intensive. As detailed in the PSMP, the government is also adopting policies to aggressively grow the economy to a developing country by 2024

through growth in heavy-manufacturing industry. With the population growth rate falling drastically over the last two decades and the probability that the average number of children per household will at the very least continue at its current figure of 2.1, a rise in per capita GDP, an increase in energy and emission intensity would greatly increase the per capita emission level without an increase in the share of renewables.

Beyond Nationally Determined Contributions:

It is important to note that even if the country continues its current policy, it will fail to achieve not only the very modest targets set by the INDCs but will also fail to reach the emission target that is globally required for limiting the negative impacts of climate change. Since the timeline of the latest power plan is till 2041, it is important to extend the analysis beyond the 2030 target set by the INDC. With a slightly larger timeframe of two decades to 2050, Bangladesh's projected per capita emissions under the policy is more than double the required target.

For a 50% chance of limiting warming to 2 degree Celsius global CO_2 emissions for 2050 must be 10E+9 mt (metric tons) as showed by Van Vuuren et al. (2008). In accordance with the Paris Agreement, the Nationally Determined Contributions (NDCs) of the OECD[1] (Organisation for Economic Co-operation and Development) countries will provide almost three-quarters of the emissions reductions in 2050, and thereby is allowed one-quarter of the emissions, while the rest of the world will be allowed three-quarters of the emissions. Using the population projections for OECD countries and rest of the world from World Bank and OECD data, we can thus calculate the per capita 2050 emissions target for non-OECD countries, which includes Bangladesh. This limits Bangladesh's coal-power generation to around 5% of total generation. The calculation is shown in Table 5 and explained below.

For 2050 projections the total primary energy consumption of Bangladesh excluding transportation and biomass (2050 projection) is taken to be 1.53E+12 kilo Watt-hour (kWh) and the population projection is 2.02E+8, assuming the trends of both variables to hold from their 2030 projections included in the PSMP. Since we know the energy mix for 2041 government plan we can project the emission using Carbon Dioxide Information Analysis Center (CDIAC) data. CO_2 emissions per kWh of fossil fuel source are assumed to be: Coal 9.80E-4; Natural Gas 5.43E-4; and Oil 7.98E-4 mt. For a sustainable alternative plan, the share of Gas and Oil is kept the same as in the government plan. Working backwards we see that to be within the 2050 per capita emission target, renewables and efficiency measures must account for 63% of the demand, assuming zero emission per unit output for renewables.

Table 5: 2050 emission calculations for two paths

2041 Government Plan (10 renewable, 10% imported)			
Coal	0.50	76.37	74.82
Gas	0.25	38.19	21.13
Oil	0.05	7.64	6.10
total emission			102.05
Government Plan per capita emission (mt)			**5.05**
Alternate Plan (63% renewable) per capita emission fixed at 1.8mt			
Coal	0.05	7.64	7.48
Gas	0.27	41.24	22.82
Oil	0.05	7.64	6.10
total emission			36.40
Alternate Plan per capita emission (mt)			**1.80**

Renewables, particularly solar power, including rooftop solar, is already proving to be a viable alternative for Bangladesh. Increased investments, particularly from emerging financing sources such as from Asian policy banks, in renewable power generation and in efficiency measures, such grid upgrades and efficient urban rail systems; favorable tax rebate and pricing policies for renewables will be

1 35 States including: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israël, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

needed to keep the country's emission within the 2050 target.

Conclusion

The case and study and comparison of policies governing the investments show that going forward national policies of borrowing countries need to be revaluated and further strengthened. It is essential Bangladesh's national policy take a longer-term view with respect to mitigation, particularly GHG emissions associated with power generation. Despite growing energy demands, the need for a low-carbon growth path is more urgent than ever— with arctic ice melting faster than expected and many scientists predicting that the world is dangerously close to exceeding our carbon budget consistent with the less than 2 degree Celsius target.

National policies are also set to play an ever increasing role in moderating the impacts of energy investments as MDBs rely more on country or client system, and private finance is set to play a larger role in infrastructure investments, including for Bangladesh. On the other side, we see how financiers, such as China Export Import Bank, have incorporated environmental and social safeguard policies for their international investments in recent years and signatories of the Equatorial Principles can help ensure sustainable financing for private investors. Though these policies do not guarantee proper implementation on the ground, explicit requirements of third party monitoring and inclusion of grievance mechanism that are easily accessible help set a system of checks and balances to ensure better implementation.

As many developing countries struggle to balance its energy needs with its developmental and climate change concerns, it is important not to approach these challenges through separate lenses of development and environment. Energy production has costs and benefits other than GHG emissions, which include livelihood considerations— such as job creation and land-use issues such as access to natural resources that are crucial for lives and livelihoods for many marginalized communities; environmental impacts, including pollution, and impacts on ecosystems; and social impacts such as displacement and health hazards from power plants. The socioeconomic and ecological resilience of communities, in turn, determine their adaptativeness to climate change impacts. As more and more countries in the Global South expand energy production in the coming decades, it is important for countries with multiple vulnerabilities to assess the needs of their at-risk population. This research can hopefully serve as a way to highlight the challenges faced by impacted communities in vulnerable countries like Bangladesh and demonstrates the need to create a push for clean energy from within vulnerable countries in the Global South appealing to governments and donor agencies from the Global South who are set to play an increasingly central role in our energy future.

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1. Sources Reviewed

Following the 2011 case study on the Marlin Mine and the 2013 study Chinese Mining in Latin America, the methodology for this work was to first identify the key impacts of coal power plant, then identifying the groups who are most impacted or involved in each aspect. The five key aspects and players were identified and methodology was developed by reviewing:

- The Zarsky and Stanley (2011) Searching for Gold in the Highlands of Guatemala: Economic Benefits and Environmental Risks of the Marlin Mine;
- Irwin and Gallagher (2013) Chinese Mining in Latin America: A Comparative Perspective;
- Newspaper articles (Daily Star, Prothom Alo, Shongbad, New Age, and Dhaka Tribune) on power plants in Bangladesh;
- Conversations with and reports from the following groups:
  - International civil society organizations and watchdogs looking at power plants (NGO Forum on ADB);
  - Bangladeshi civil society organizations (Bangladesh Poribesh Andolon, Bangladesh Environment Network, Bangladesh Environmental Lawyers Association) who are involved in communities impacted by large power plants;
  - Research organizations working in energy and environment (Center for Policy Dialogue, Bangladesh Center for Advance Studies, Bangladesh Enterprise Institution, Department of Environment, Khulna University and Dhaka University);
  - And relevant government sectors (MoPEMR, Ministry of Environment, Bangladesh Bureau of Statistics, Dhaka Power Development Board, Ministry of Finance, Sustainable and Renewable Energy Development Authority).

Identities of individuals I interviewed or communicated with have been omitted from this paper due to the government response to the mine expansion and subsequent pushback to protests.

2. Information collected

The questions were developed in part around relevant stakeholders who are involved in the process of examining the questions above. The stakeholders can be grouped in the following categories:

i) Government sectors (Ministries of Power and Energy/Environment):

Questions relevant to this group are regarding:

1) the land acquisition process 2) financing aspect- amount of state financing and co-financing 3) project selection process 4) royalty amount, tax/duties/subsidies, price guarantees/government purchase 5) environmental assessment studies 6) social impacts assessment and what grievance mechanism are available to employees, local communities and 7) cost and price projections for various energy sources. 8) What are the demographic features of the communities: general idea of the household level of income, occupation, age, and ethnicity? 9) More broadly: what support is the government providing for power generation— support in terms of government regulations and agreements under favorable terms, access to finances, availability of financing instruments?

ii) The entities in charge of the power plant.

For Barapukuria this was the Bangladesh Power Development Board (PDB):

The questions relevant to this group are: 1) how many employees do they have? 2) are the employees local? 3) what is the national content in terms of inputs such as machine 4) have there been any environmental and social impacts 5) are there mechanisms in place for communities/employees to seek redress should the need arise? 6) what are the tax, duties, subsidies, price projections, and insurance agreements? 7) More broadly: what support are they receiving from the government and other entities such as multilateral and commercial institutions— support in terms of government regulations and agreements under favorable terms, access to finances, and availability of financial instruments?

iii) Civil Society Organizations (CSOs)/journalists/activists/researchers/academics working on power plants:

What are the economic, social and environmental impacts of the power plant? Are there relocated people and have they been compensated properly? Do those relocated have alternate adequate livelihood options? Have their access to resources been curtailed? What are employment opportunities and conditions at the power plant? Have there been land acquisition issues? If there have been pollution, flooding, lack of water etc. what steps have been taken by the various parties involved? How much local/national jobs have been created? Are there local/national benefits from plant or from ancillary investments around plant (e.g. road, better electricity access etc.)? What are the demographic features of the communities: general idea of the household level of income, occupation, age, and ethnicity?

iv) The local communities and employees:

The same questions asked to the third group above were asked to this group.

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