The Alternative Power and Energy Plan for Bangladesh

Draft for consultation prepared by **National Committee to Protect Oil Gas Mineral Resources Power and Ports, Bangladesh (NCBD).**

Abridged version

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Introduction

The corporate interest driven energy and power generation system has massively affected the global environment, agriculture and water bodies; it also caused global conflict, war and occupation. The conventional ideas of development have largely failed to accommodate the basic needs of people and ecology.

In the same policy frame work the governments of Bangladesh have been working to ensure profit for few. While consequent governments of Bangladesh have been pursuing corporate controlled, private profit centric, debt dependent and environmentally disastrous energy and power policy, a strong democratic peoples movement has also emerged to resist this. The movement on the one hand put demand to scrap anti-people and anti-environment deals, it advances the vision of equity, pro-environment energy security and pro-people technological advancement on the other. To reflect peoples aspiration the National Committee worked hard to find an alternative energy and power plan, containing the vision of a progressive, egalitarian, democratic, pro-nature, and pro-human development model.

Relying on two decades long experience of peoples' movement, along with a yearlong research, investigation, and dialogues with a large number of scientists, environmentalists, engineers, and renewable energy experts from all around the world, National Committee is delighted to present this pro-people, pro-environment master plan for the people of Bangladesh to meet energy and power demand. This alternative plan proposed by the National Committee has prioritized people's ownership of all natural resources, protection of environment, development of national capability, and the use of environmental friendly technology. We would like to ensure a democratic way of participation of people and experts around the globe in the process of develop it further and implement it. We welcome your feedback and active participation in the process.

Section I

The Critique of Government Proposed PSMP 2016

In 2016, the Government of Bangladesh has presented a Power System Master Plan (PSMP 2016) for the power and energy sector of Bangladesh.[1]National Committee has identified a number of limitations and hazards of the Master Plan.

- This 'Master Plan' was prepared by JICA (Japan International Cooperation Agency). It lacks the engagement of the local and independent experts of the country.
- The PSMP overlooks critical aspects of Bangladesh's topography, population density, resource distribution, energy security, national capability, and ecological risks.
- It exhibits clear indications of heavy influence excreted by international big business groups. The proposed projects under PSMP are exclusively import based, debt dependent and dominated by foreign corporate interest. Also, no public consultation has been taken place before finalizing the 'Master Plan'.
- The government plan exclusively focuses on Coal, LNG, and Nuclear Energy.
- Most proposed projects are ecologically harmful and highly expensive in nature.
- No comprehensive plan is laid out encouraging gas exploration by BAPEX[2] in shallow and deep water seas in Bay of Bengal. Gas based power plants have been made exclusively dependent on imported LNGs.
- The Government proposed master plan has encouraged price increase of gas and electricity on regular basis. According to the Master Plan 'every year the price of gas has to be increased by 19-29%, considering LNG importation and international gas price hike' (PSMP 2016: pp 21-27).
- Though globally, power generation based on renewable resources has expanded at an unprecedented level, the government proposed plan has not only overlooked the prospect of it, it has manipulatively showed a higher price for solar based electricity.

[1]Government of Bangladesh. Power Sector Master Plan 2016. Ministry of Power, Energy and Mineral Resources. September 2016.
[2]Bangladesh Petroleum Exploration Corporation is a state owned institution responsible for exploration and extraction of petroleum products (oil, gas, mineral resources) within the country.

- In case of Nuclear Energy, apart from other risks, the hazards of nuclear waste management, transportation issues, insurance cost and decommissioning cost have not been addressed with due seriousness.

PSMP 2016: Overlooking Environmental Concerns

The government's preference of coal and nuclear power plants has created huge risks for people and environment. Some of the risk of fossil-fuel based power generation are discussed below:

Coal

The heavy release of toxic chemicals and the risk of intense consumption of water for each coal fired power plant[3] is already widely discussed in the public domain in Bangladesh. The Major risks of a Coal-fired power plant in the context of Bangladesh have been identified to be as following:

- SO2, CO2, and NO2: It scientifically evident that coal fired plants emit large quantities of air pollutants, including Sulphur dioxide (SO2), Carbon dioxide (CO2), Nitrous oxides (NOx), Mercury and other heavy metals, leading to smog and acid rain, which cause numerous respiratory, cardiovascular, and cerebrovascular effects.[4]

- Acid Rain: The effect of acid rain is particularly noticeable in aquatic environments, causing acidification of waterways and leaching aluminum from the soil, thereby harming the faunas and floras of the ecosystem.

- Mercury: Mercury is a potent neurotoxin that impairs the brain development of infants and children, and has been linked to various heart problems. Mercury accumulates in water bodies and subsequently in the tissues of fish.

- Coal Sludge: Coal Sludge is the liquid coal-waste generated by washing coal. It is typically disposed of at impoundments located near the coal mines. In some cases, it is directly injected into abandoned underground mines. Since coal sludge contains toxins, leaks or spills can endanger both underground and surface waters.[5]

- Coal Waste: Coal combustion waste is considered to be the largest waste stream after municipal solid waste. It is disposed of in landfills or 'surface impoundments', which are lined with compacted clay soil or plastic sheets. As rain filters through the toxic ash pits year after year, the toxic metals are leached out into the local environment.[6]

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[3]An average of 1000 MW Coal power plant consumes around 3000 liter/MWh

[4]Rachel's Environment & Health News, "Green Coal?," November 6, 2008. Retrieved from http://www.precaution.org/lib/08/prn_is_coal_green.081106.htm

[5] Rachel's Environment & Health News, "Green Coal?," November 6, 2008. Retrieved from http://www.precaution.org/lib/08/prn_is_coal_green.081106.htm

[6]Rachel's Environment & Health News, "Analyzing why all landfills leak," February 14, 1989.

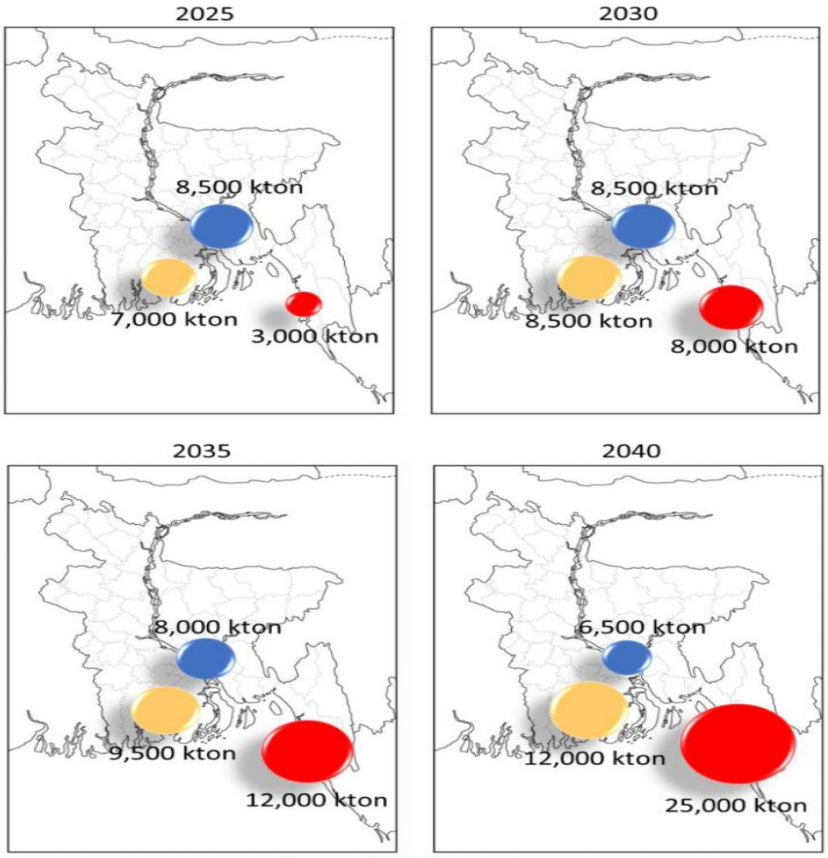
- Loss of Groundwater: Since coal seams often serve as underground aquifers, removal of coal beds may result in drastic changes in the hydrology of the area of mining.

- Coal Ash: It is estimated that a typical 1 GW capacity of coal fired power plant generates over one million ton of coal ash per year containing various toxic metals including arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and radium, all of which are evidently harmful for health and environment.

- Transshipment Risks**:** PSMP-proposed coal power plants (19000 MW) and Coal Transshipments Terminals (CTT) are to be built along the coastlines of the southern part of Bangladesh. Massive amount of coal transportation (52 million tons per year) through the southern wetland and water bodies bear the risk of destruction of forestry and ecosystem services.

Figure 1:

Picture of Imported Coal Transportation Routes and Coal Transshipment Terminals



Source: JICA Survey Team

Figure 11-18 Prospective imported coal amounts by 2041 (Unit: kTon)

Risks Related to Nuclear Power Plant

The Government-proposed master plan set the target to install 7.2 GW of nuclear power plant within next 24 years.[7] An agreement has already been signed with the Russian Company Rosatom in order to set up a 2600 MW capacity Power plant at Ruppur, Bangladesh.

Apart from basic hazards of nuclear energy, the following risks are identified:

- Nuclear power plants bear the risks of waste leakage (by the use of radioactive materials in nuclear power plants), waste transportation leakage, and reactor accidents. The management of spent fuel as well remains an issue of hazard.
- An average of 1 MWh of electricity from nuclear power plant consumes as much as 3000 liters of water. Considering the ongoing water crisis in the northern part of the country, a number of experts have already denounced the proposal of nuclear power generation in Bangladesh.[8]
- Nuclear technology is a great burden for the state in terms of its excessive upfront cost. Considering insurance liability, decommissioning cost, and the continuous upgrade of safety measures, nuclear technology is perceived to be the most expensive means to produce electricity.
- The construction agreement between Bangladesh Government and 'Rosatom' on Ruppur Nuclear Plant follows a *cost plus* model rather than a fixed cost model.[9] This gives flexibility to the Russian construction company to raise its cost along with its profit margin in different times.
- Lately an indemnity Bill is passed by Bangladesh government which legally shields the partner company (Rosatom) in case of any 'unintended' damage during the operational phase of the power plant.

[7]Government of Bangladesh. Power Sector Master Plan 2016. Ministry of Power, Energy and Mineral Resources. September 2016.

[8]Suggested by following experts in different occasions: A. Rahman, Retired nuclear scientist and a fellow of the British Nuclear Institute. M V Ramana (Princeton University and the author of The Power of Promise: Examining Nuclear Energy in India). Zia Mian (Princeton University, co-edits Science & Global Security, the International Technical Journal of Arms Control, Nonproliferation and Disarmament).

[9] Rahman A., "Ruppur Nuclear Power Plant: Bangladesh's Potential Blackhole," The Daily Star, 2015. Retrieved from http://www.thedailystar.net/op-ed/politics/ruppur-nuclear-power-plant-bangladeshs-potential-blackhole-194017

Section II

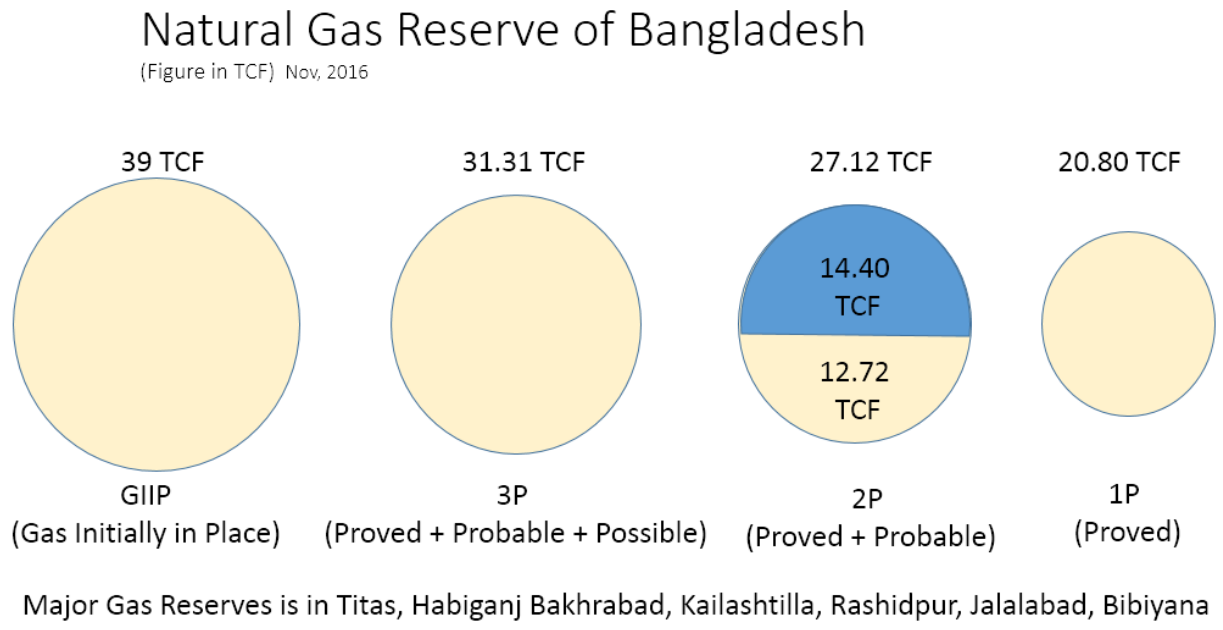
National Committee's Position on Gas, LNG and Renewable Energy

- National Committee has consistently warned that one of the underlying objectives of PSMP 2016 is to make the economy heavily dependent on imported coal and LNG, which would eventually drastically push up the price of electricity.
- National Committee holds a firm position against the government's extensive plan of foreign investment dependent, high cost, environmentally harmful power generation. It holds a strong position against the government plan of coal and nuclear based power generation considering the massive environmental and social cost it would generate.
- National Committee believes domestic sources of gas (both onshore and offshore) could be one of the principal sources of energy for Bangladesh if appropriate policies are taken.
- National Committee also holds a strong position in favor of massive expansion of renewable energy in Bangladesh within the next 25 years.

Natural Gas Resources in Bangladesh: Current Reserve and Potential

According to the U.S geological survey the total undiscovered gas resources located both in the mainland and shallow sea blocks amounts up to 32 TCF (based on 50 percent probability).[10] The present reserve of natural gas of Bangladesh is estimated to be around 13 TCF.

Figure 2:



[10]PetroBangla. Final Updated Report on Bangladesh Petroleum potential and resource Assessment 2010. Hydrocarbon Unit and Energy and Mineral Resource Division. Government of Bangladesh. June 2011.

It is to be noted that no significant assessment has been taken place in the deep sea blocks of the Bay of Bengal. However, it is predicted by renowned geologists of Bangladesh that around 6 TCF gas resources can be located only one block in the Bangladesh-owned deep sea area of Arakan basin.[11] The possibility of gas discovery in the Arakan basis is re-enforced by the fact that currently Korean company Daewoo has discovered around 9 TCF natural gas in different gas field adjacent to the above mentioned deep sea blocks.[12]

It is also important to note that no significant gas exploration activity has occurred in Bangladesh since 2000. National Committee believes that the government of Bangladesh has purposefully restrained from developing national institutions, while consciously encouraged a 'planned dependence' of the state over the foreign companies in the development of the energy sector. No specific plan is laid out in PSMP 2016 requiring the direct and long term involvement of the state in building competitive institutions to ensure the best utilization of the gas resources of the country. Experts believe that if appropriate policies and proper exploration activities are initiated by the government in the deep sea blocks, domestic gas resources would be able to meet the demand of the power sector up to the year of 2050 with no significant depletion.

National committee believes that it is vital for the government to take the following measures in gas sector:

- Scrap anti-people export oriented contracts with multinational companies on gas sector.
- Develop institutional capacity of the national exploration companies, such as PetroBangla, Hydro Carbon Unit, and BAPEX.
- Initiate intensive gas development and exploration activities through state owned institutions.

Renewable Energy: New Horizon

Around the world, the use of renewable energy has become the prime choice for ensuring affordable, reliable, and clean energy services. A large number of countries have already set their renewable energy targets and reformed their policies to enhance their institutional capacity to adopt a renewable energy based power system. Recent studies by IRENA and BNEF have shown that renewable sources are competitive, attractive to investors and have the potential to create millions of new jobs around the world.[13, 14] The growing maturity of the renewable energy market coupled with technological advancement and policy refinement leads to an energy reform 'boom' all over the world.

[11]Consultation with the leading geologist and Dhaka University Professor Badrul Imam.April-May 2017
[12]Filipov, Allan; Dilindi, Robert; Drage, Magne. Electro-Magnetic Sensitivity in the Bengal Basin: Implications for Exploration in Mynmar, Bangladesh and NE India. International Petroleum Technology conference. 10-12 December. Malaysia.

[13]Renewable Energy and Jobs – Annual Review 2016, International Renewable Energy Agency, Published in 2016, p. 17.
[14]Global Trends In Renewable Energy Investment 2017, Frankfurt School of Finance & Management, Published in 2017, p. 11.

Within this global framework, after long investigations, National Committee is now convinced that Bangladesh holds immense opportunity to build a renewable resource driven power system. If appropriate institutional, social, and market measures are taken, Bangladesh could generate a major portion of its electricity from the renewable sources by 2041.It is important to note that renowned international institution including Renewable and Appropriate Energy Laboratory (RAEL), University of California, Berkeley and National Renewable Energy Laboratory (NREL) and Institute of Energy Economics and Financial Analysis (IEEFA) have estimated the potential of solar based energy in Bangladesh to be 120 GW and 380 TWh (240 GW) respectively.[15, 16]

Renewable Energy: The Financial, Environmental, and Technological Considerations

On the contrary, the government PSMP specified a potential of only 3666 MW of electricity from renewable sources, which constitutes only 6.5% percent of the peak demand of 2041. It is important to note that the government proposed renewable sources does not constitute only local sources but rather includes imported hydroelectricity as well.

National Committee strongly believes that the massive potential of renewable energy in Bangladesh is purposely ignored by PSMP 2016, in order to protect the business interest of various vested interest groups (including the coal and nuclear lobby). Considering both local and global financial, technological and environmental competitiveness of renewable energy, National Committee holds a strong position in favor of countrywide expansion of different sources of renewable energy in Bangladesh.

However, it is important to note that a number of common misperceptions prevail in Bangladesh regarding the potential of solar energy. These include:

1. Solar irradiation is insufficient
2. Required land is not available
3. Agricultural land can't be used for Solar
4. Flood prone areas can' t be used for Solar
5. Bangladesh lacks efficient technology
6. Solar technology is expensive

This research counters all of the above prevailing arguments which have been consistently pushed by fossil-fuel based lobbyist groups. The environmental, financial and technological arguments for renewable energy are discussed below.

[15]Solar Resources By Class and Country, National Renewable Energy Laboratory, November 25, 2014, Retrieved from: http://en.openei.org/datasets/dataset/solar-resources-by-class-and-country.
[16]Bangladesh Electricity Transition: A Diverse, Secure and Deflationary Way Forward, November 2016, Institute for Energy Economics and Financial Analysis, Published in 2016, p. 22.

Environmental Consideration

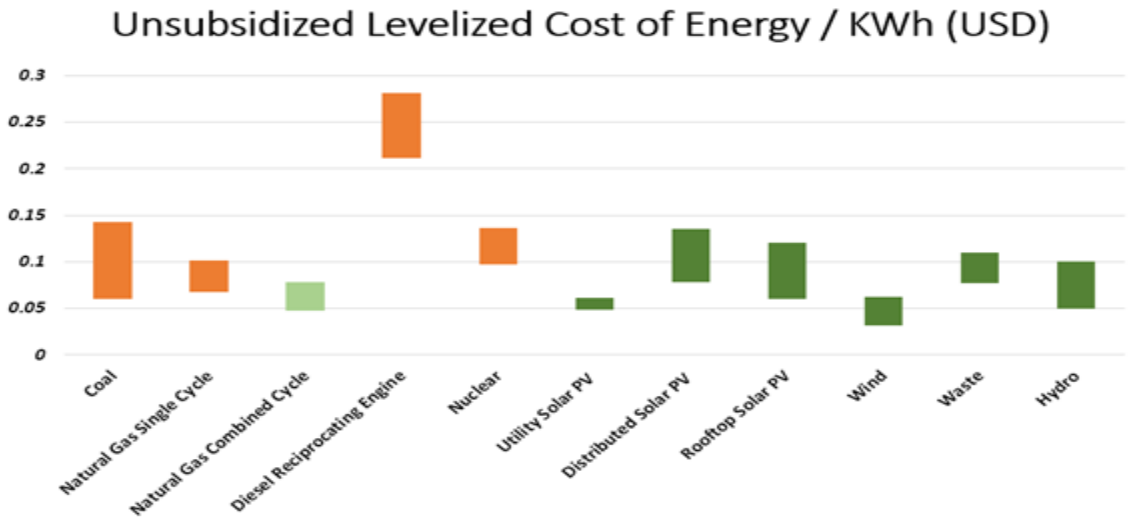
- As most renewable sources (Solar, Wind, and Biogas) produce minimal contamination to water, agriculture, soil and air, it is considered to be safe for biodiversity, ecology, and community livelihood.
- Renewable sources also hold no risks of accidents (oil spill, coal cargo drowning, radioactive waste leakage, and reactor accidents).

Financial Consideration

Solar technology has experienced a sharp decline in the recent years. For instance:

- Both capital investment and levelized cost of renewable electricity has been dropped more than 50 percent in between 2010 to 2015.[17]
- Currently (2016) per unit electricity generation cost of different sources of renewable energy is $0.03-$0.12.[18] Whereas current unit electricity generation cost of different conventional energy sources comes up to $0.06 to $0.28 (see following figure).[19]

Figure 3:



Electricity Generation Cost/kWh (USD)[20]

[17]The Power to Change: Solar and Wind Cost Reduction Potential to 2025, International Renewable Energy Agency (IRENA), Published in 2016, p. 10.
[18] The Power to Change: Solar and Wind Cost Reduction Potential to 2025, International Renewable Energy Agency (IRINA), June 2016 (p.11).

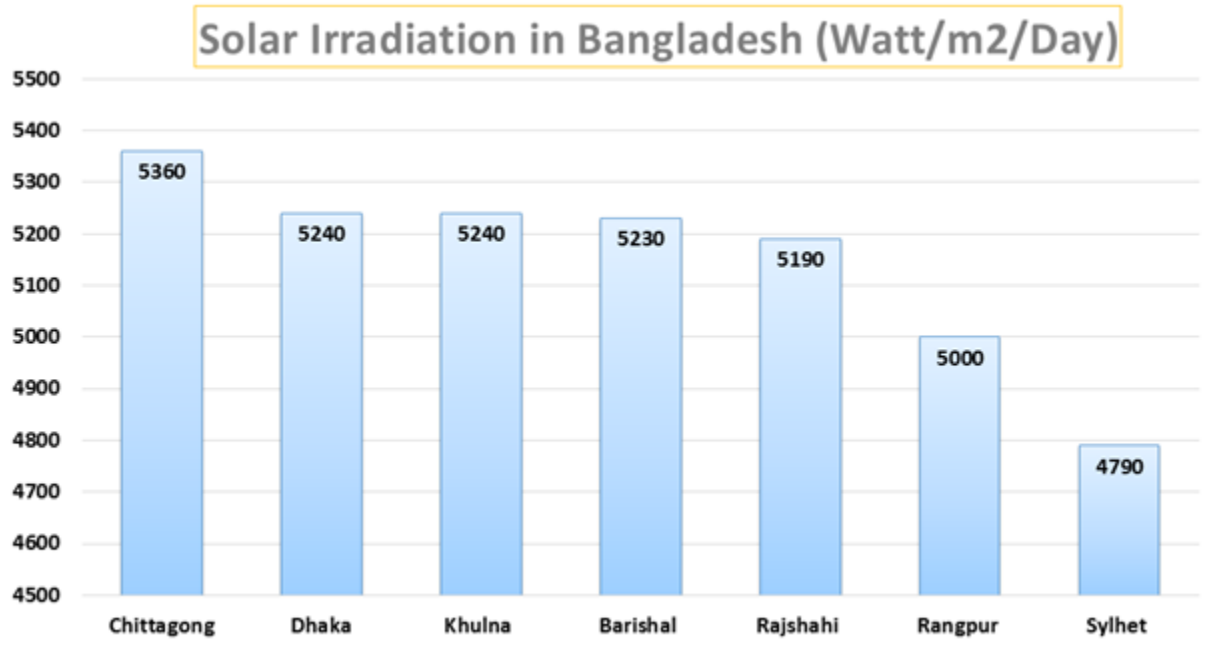
[19]LAZARD. Levelized Cost of Energy Analysis, Available at: https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-100/
[20] LAZARD. Levelized Cost of Energy Analysis, Available at: https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-100/

Technological Consideration: Solar Energy in the Context of Bangladesh

To examine the actual solar potential of Bangladesh, the following points are needed to be considered:

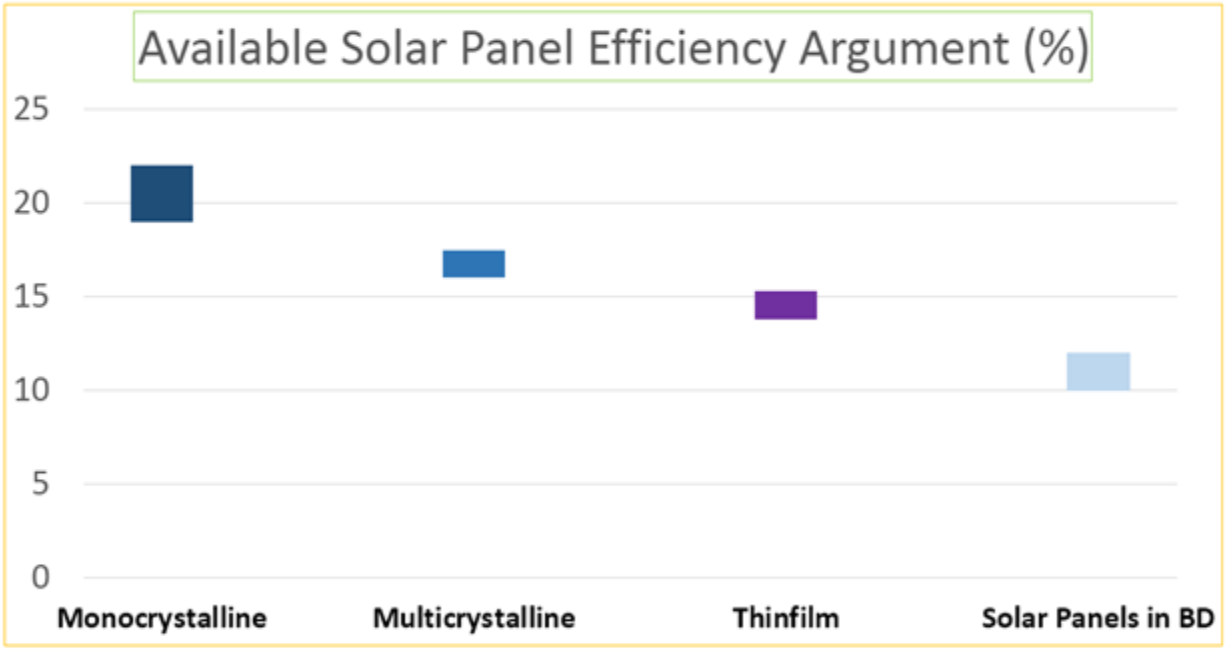
- Bangladesh receives around 3000 to 5500 watt/square meter solar irradiation per day (see figure below).
- The average solar irradiation in major cities of Bangladesh is higher than any other cities in Germany.
- Monocrystalline, Polycrystalline and Thin film solar panels of present technologies have field efficiency up to 22%, 18% and 15% respectively. However, Bangladesh Market is still stuck with 10% Panel Efficiency, while charging high price for the low efficiency products (see figure below).

Figure 4:



Source: Strzalka, Aneta; Siddiquee, Zahid Hasan & Eicker, Ursula. "Potential of Roof Top PV- System for Supplying Electricity in Residential Area." ICDRET'09, December 17-19, 2009, Dhaka, Bangladesh, (NREL) National Renewable Energy Laboratory. "Solar Irradiation of Bangladesh". http://pvwatts.nrel.gov/pvwatts.php"

Figure 5:



Land Considerations

There is a widespread conception that solar installments require use of massive amount of land which would eventually reduce the land availability for agriculture production. Existing policies of Bangladesh government also disallows the use of agro land for solar based installments.

However, it is important to note that existing technology itself allows the use of agriculture land for solar production. It is already scientifically tested that both agriculture and solar based energy production can be implemented in the same land by using solar-sharing technology.[21]

[21] *The Hindu*. Adani's 648-MW solar plant inaugurated. September 22, 2016. Retrieved from http://www.thehindu.com/news/national/tamil-nadu/Adani%E2%80%99s-648-MW-solar-plant-inaugurated/article14993341.ece)

Figure 6:

Solar Sharing: Agriculture and Solar Production in the Same Land

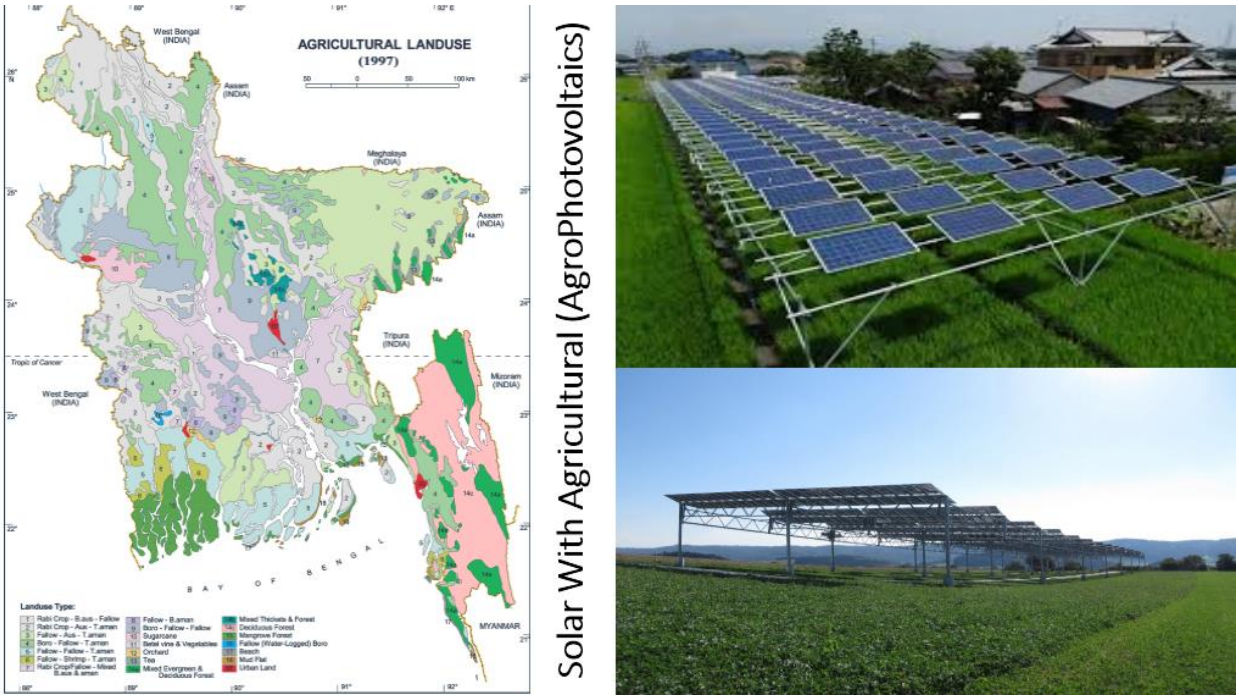


Image on left: Use of agricultural land: Bangladesh. Available at http://www.thebangladesh.net/agricultural-landuse-of-bangladesh.html#map-1,

Image on right: Use of Photovoltaics and Photosynthesis – Pilot Plant at Lake Constance Combines Electricity and Crop Production. Available at https://www.ise.fraunhofer.de/en/press-media/press-releases/2016/photovoltaics-and-photosynthesis-pilot-plant-at-lake-constance-combines-electricity-and-crop-production.html

Land Requirement

Though in general 4 acres of land is commonly observed to be used to produce 1 MW of electricity, recent studies have confirmed that the production of 1 MW of electricity might require as less as 2 acres of land. For instance, according to a research produced by Federal Ministry for Transport and Digital and infrastructure (Berlin) (2015), as less as 1.7 Acres of land could be used to produce 1 MW of electricity. On the other hand, a 648 MW capacity solar power plant in Tamil Naru, India, used around 2,500 acres of land lately, indicating the requirement of 3.86 acres of land for each MW of electricity.

We believe that a large portion of the un-used state owned land in Bangladesh could be allocated for the use of solar based power generation. It is important to note that the use of ‘bulk’ land is not essential for the generation of solar energy. Instead, considering the land scarcity of the country, it is preferable to adopt a decentralized-land-based solution for Bangladesh. A decentralized mechanism is widely used in different parts of the world for solar based energy in which the clients are encouraged to send the un-used/surplus electricity to the national grid. It is

viable to produce the desired amount of electricity by including the rooftop spaces of different urban establishments including market places, hospitals, schools, universities, office spaces.[22]

It is important to note that by the year of 2041, the energy demand for Bangladesh is estimated to be 238 Terawatt-hour. According to the Institute of Energy Economics and Financial Analysis (IEEEFA) Bangladesh can produce as much as 380 Terawatt-hours of electricity only by using by 2 hundred and forty thousand acres of land. Based on expert panel calculation it is viable to produce around 100 Terawatt-hour of electricity which would require around 0.55 percent of the land area of Bangladesh (considering 1 MW solar plant installation requiring 4 acres of land with 12% efficiency).

Figure 7: Required Land for 1 MW Capacity Solar Plant Based on Varied Panel Efficiency

	Distributed PV				Utility Scale Acre/1 MW
Plant capacity	**1 KW**	**2 KW**	**5 KW**	**10 KW**	
Panel efficiency	**Rooftop space required (SF)**				
12%	125	250	625	1250	4
12.50%	120	240	600	1200	3.8
13%	115	231	577	1154	3.6
13.50%	111	222	556	1111	3.5
14%	107	214	536	1071	3.4
14.50%	103	207	517	1034	3.3
15%	100	200	500	1000	3.15
15.50%	97	194	484	968	3
16%	94	188	469	938	2.75

Source: NCBD Research Team Solar Fact Sheet (Required Space for Distributed Solar System [UP to 10 KW] based on Efficiency.

[22](IEEFA) Institute of Energy Economics and Financial Analysis. "Bangladesh Electricity Transition: A Diverse, Secured, Deflationary Way Forward." November, 2016. p. 22.

The Issue with Flood Prone Area

One of the major concerns regarding solar potential in Bangladesh is that due to the presence of low-lying wet lands and flood-prone areas in the major portion of the landscapes of Bangladesh, solar installation may not seem feasible during the monsoon time. However, evidences show that large scale solar installation can also be managed in the flood prone areas in Bangladesh through the proper implementation of existing technologies and mean. For instance, floating solar panels and solar sharing technique have already been proven to be successfully operating in the flood-prone areas of Japan. A major portion of the shrimp farming areas of Bangladesh can also be benefitted by solar power projects as it helps reducing the evaporation rates of canals. Solar panels installed above the Irrigation canals of Gujrat, India not only contributed to the energy generation but also to the lower evaporation of the canal waters.

Figure 8: Floating Solar in Flood Prone Area

Flood Map, Available at: http://www.thebangladesh.net/flood-maps-of-bangladesh.html

Figure 9:

Flood Prone Area and Solar With Fish and Shrimp Firming

Image on left: Traditional Shrimp firming in Bangladesh. Available at https://www.seafood-tip.com/sourcing-intelligence/extensive-production-system/;

Image on right: Power station for both fishing and solar energy, available at http://www.gettyimages.co.uk/event/power-station-for-both-fishing-and-solar-energy-built-in-jiaxing-562698587#solar-panels-for-both-fishing-and-solar-energy-are-seen-at-heshan-of-picture-id479105280

Potential for Rooftop-based Solar in Bangladesh

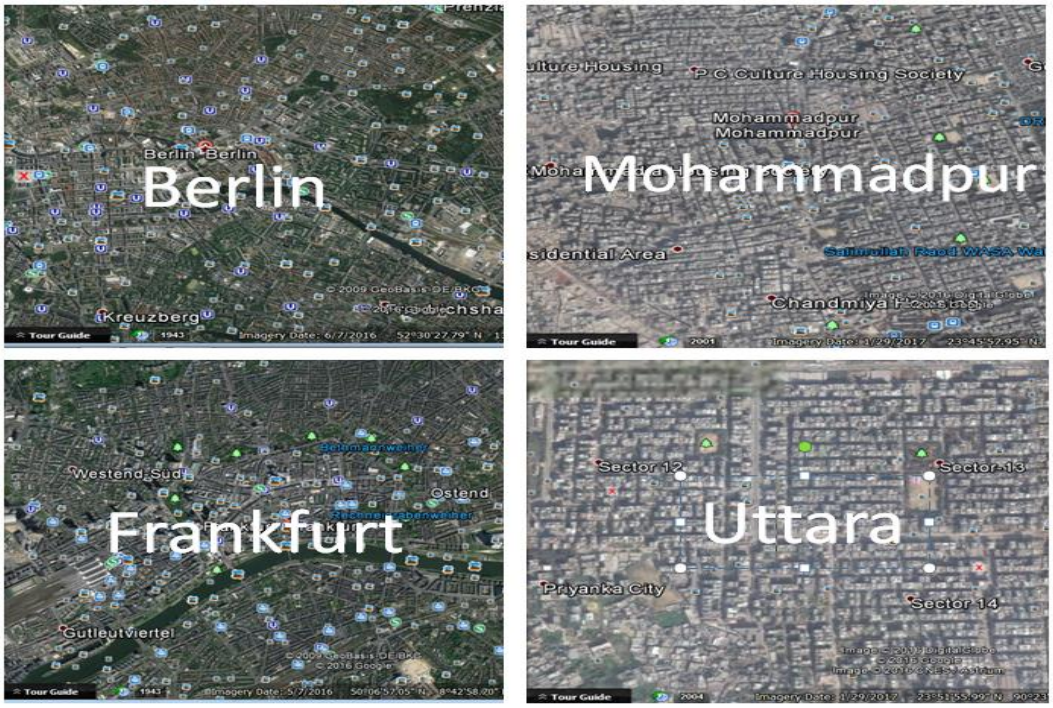
The following chart shows a comparative picture of rooftop areas in two urban hubs of Bangladesh and Germany. It is visually evident that urban cities in Bangladesh have more rooftop based solar potential compared to German cities. Unfortunately, no detail study has been done exploring the total rooftop potential in Bangladesh. We believe that the following measures should be taken to initiate and expand the installation of rooftop based solar projects. For instance:

- To identify the actual rooftop areas in the urban cities of Bangladesh
- To propose an appropriate financial incentive package for both commercial and household installation.
- To develop an appropriate infrastructure in order to supply rooftop-based surplus electricity to the national grid.
- To propose an appropriate tariff rate for both commercial and household clients.

(See Appendix-1 for a proposed model for rural electrification)

Figure 10:

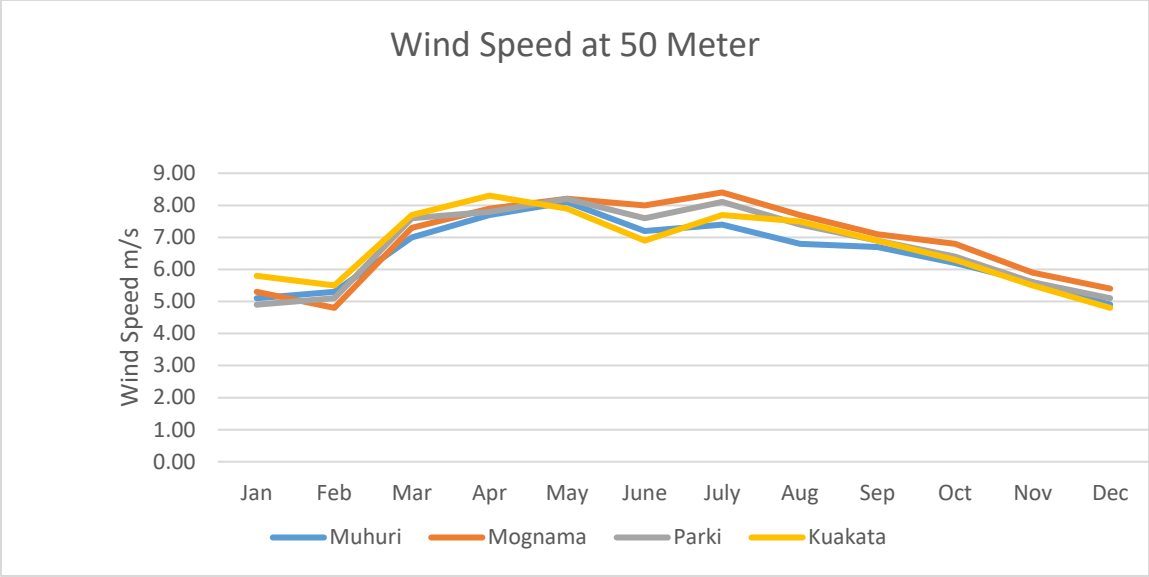
Comparative Visuals of Urban Based Rooftop Solar Potential for Germany and Bangladesh



Technological Considerations: Wind Energy

The average wind speed of Bangladesh has been noted to be 6 to 11 meter/second in different seasons at 80 meter hub height.[23] The chart shows available wind speed at different parts of Bangladesh throughout the years, at both 50 meter and 85 meter height.

Figure 11:



Reference: N. Farha, M.N.U. Safa, B.D.Rahamatullah, M. S. Ali., "Prospects of Wind Energy in the Coastal Region of Bangladesh" International Journal of Scientific & Engineering Research, Volume 3, Issue 8, 2012.

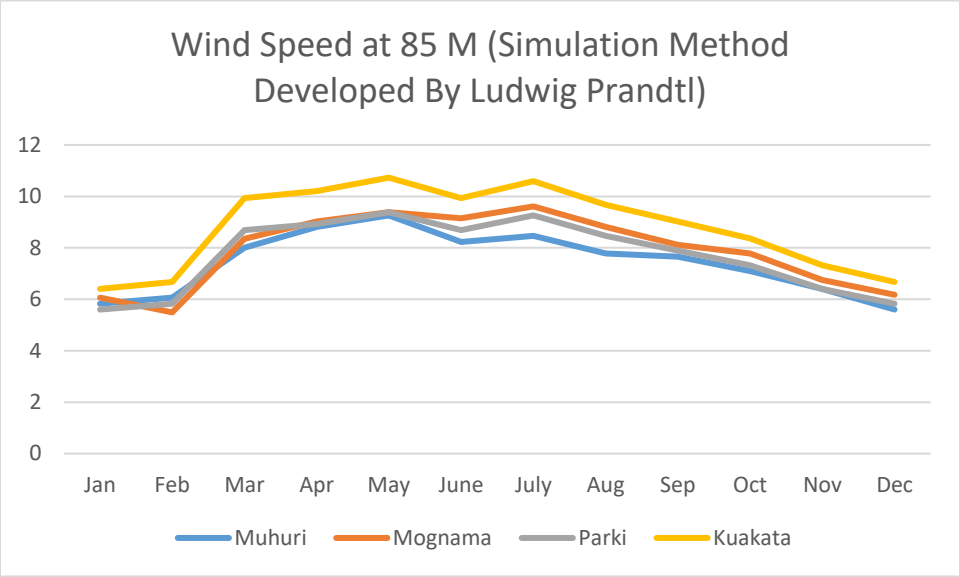
It is important to note that, within the previous 10 years wind technology has experienced an impressive level of development. Currently, it is technologically viable to produce electricity from wind with a CUT IN speed of 2 to 3.2 meter/second.[24]

[23] American Journal of Engineering Research. Wind Energy Potential In Bangladesh. Vol 5, Issue 7. 2016. pp. 85-94.

[24] (For Cutting Speed 2) I. Bayati, M.Belloli , L. Bernini , R. Mikkelsen , A. Zasso. "On the aero-elastic design of the DTU 10MW wind turbine blade for the LIFES50+ wind tunnel scale model", Politecnico di Milano, Department ofMechanical Engineering, University of Milan; Fluid Mechanics, Department of Wind Energy, Technical University of Denmark. 2016. Retrieved from (http://iopscience.iop.org/1742-6596/753/2/022028)

(For Cutting Speed 3) Cian Desmond, Jimmy Murphy, LindertBlonk and WouterHaans. "Description of an 8 MW reference wind turbine" MaREI (Marine and Renewable Energy IRELAND); University College Cork, Ireland, and DNV-GL, Turbine Engineering, Netherlands.

Figure 12:



As the generation cost/KWh of wind power has come down to US $0.055 to $0.082 (Offshore Wind), (which is comparatively far less than other conventional energy sources), it has also become commercially appealing to invest in wind energy (discussed in detail in the original research).[25]

It is already mentioned that sufficient wind is available in some particular areas in Bangladesh. The experts of the country have identified some of the wind pockets which are suitable for wind based electricity production. The list of the wind pockets are listed below:[26]

- Lalpur, Nator
- Jafarabad, Chandpur
- Inani beach, Coxbazar.
- MognamaGhat.
- Shitakundo, Chittagong.
- Parky Beach,
- Bodorganj, Rangpur.
- Gouripur, Mymensign.
- Modhupur Tea Garden, Habiganj.

[25] International Renewable Energy Agency (Irena): The Power To Change: Solar And Wind Cost Reduction Potential To 2025, June 2016

[26] (SREDA) Sustainable and Renewable Energy Development Authority Bangladesh. Wind Resource Mapping. Power Division. GOV. August 2016. Retrieved from http://www.sreda.gov.bd/index.php/site/page/2f45-680b-877b-3ec8-7bdc-f44a-721d-ac4b-1ff8-856c

- Dakop, Khulna.
- Hatia
- Saint Martin
- Kutubdia.
- Muhuri Dam, Fenni.
- Several islands and around 700 km of coastal line.

It is important to note that several internationally renowned institutions have studied the potential of wind based energy in Bangladesh. For instance, RISOE National Laboratory, Denmark, Denmark Technical University (DTU), and National Renewable Energy Laboratory (NREL) have estimated the total potential of wind energy in Bangladesh to be about 20 GW at 100 meter Hub height with 130 meter Rotor Diameter.[27] Lately a Danish company VESTAS (a Danish wind turbine manufacturing company) has completed a comprehensive study on wind monitoring and site assessments in Bangladesh. However, the results have not been made public yet.[28]

Waste Energy

Waste materials have significant potential to generate electricity and bio gas in Bangladesh.

- A SREDA[29] study shows that it is possible to generate as much as 700 MW of electricity in Bangladesh by using around 47,000 ton/day municipal solid wastes (2015) and 60 Million tons of dairy/poultry manure.[30]
- It is important to note that if appropriate measures are taken, the compost can save around 55 BCF of natural gas (amount needed to meet current demand of synthetic fertilizers).[31] It can also produce and supply around 155 BCF of bio gas.[32] The cumulative impact of waste management would also benefit the power sector once extra natural gas and electricity is supplied to the grid (discussed in detail in the original research)

[27]A.Z.A. Saifullah, M. A. Karim, M. R. Karim, "Wind Energy Potential in Bangladesh", American Journal of Engineering Research, Vol. 5 (7), pp-85-94, Available At: http://www.ajer.org/papers/v5(07)/K0507085094.pdf
[28]Wind Energy Potential Bangladesh (Baseline Study Wind Energy Bangladesh), Wind Minds and Netherland Enterprise Agency, April, 2017, p 13.
[29]SREDA. Sustainable and Renewable Energy Development Authority. Retrieved from http://www.sreda.gov.bd/index.php/site/page/6b72-7470-54bd-6140-f5b3-40c8-6b8a-b8e6-cc5c-7aa6
[30] Waste Concern. Municipal Solid Waste and Recovery Potential: Bangladesh Perspective. 2015.
[31] Research Panel Study.
[32] Research Panel Study.

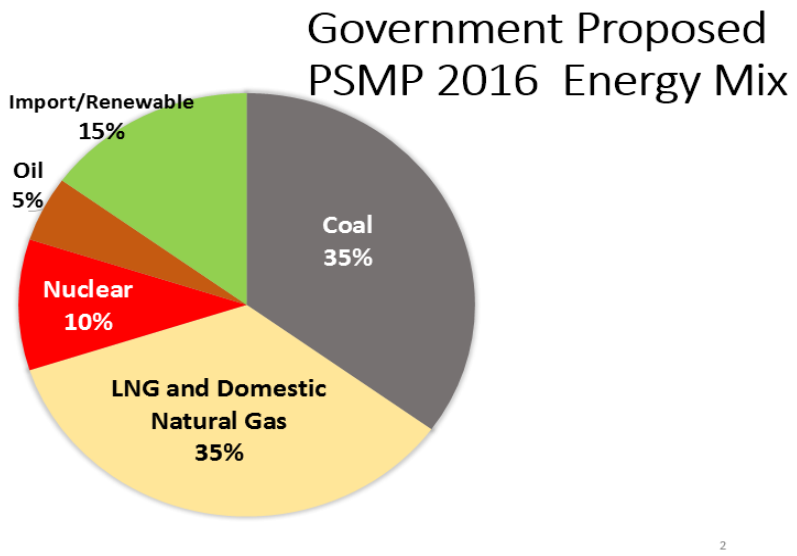
National Committee Alternative Vision

After studying all relevant studies and exploring all potentials National Committee has come up with viable, cheap and environment friendly alternatives. These are described as follows:

Current Energy Mix of Bangladesh and Government Proposal up to 2041

Currently, 69 percent of the total generation of the power sector in Bangladesh comes from Natural Gas. 21 percent of net generation comes from oil. 10 percent comes from Coal, Power Import and Hydro. Renewable energy does not constitute any significant portion of the generation.

Figure 13:

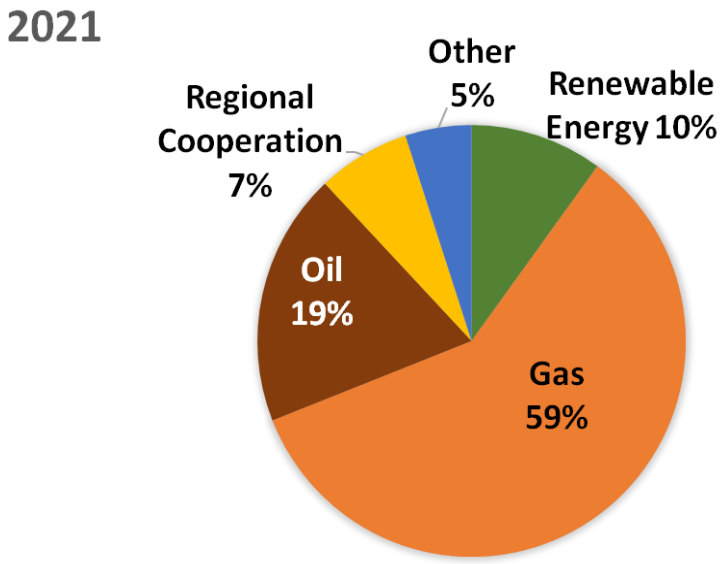


Considering the high population density of Bangladesh along with its high dependence over agriculture and water, National Committee believes that it is excessively risky to introduce a power plan highly dependent on conventional energy sources, including coal and nuclear.

The alternative master plan suggested by the National Committee is divided into three phases: short term (till 2021), midterm (till 2031), and long term (till 2041 and beyond).

National Committee proposed Short Term Energy Mix Plan (till 2021)

Figure 14:

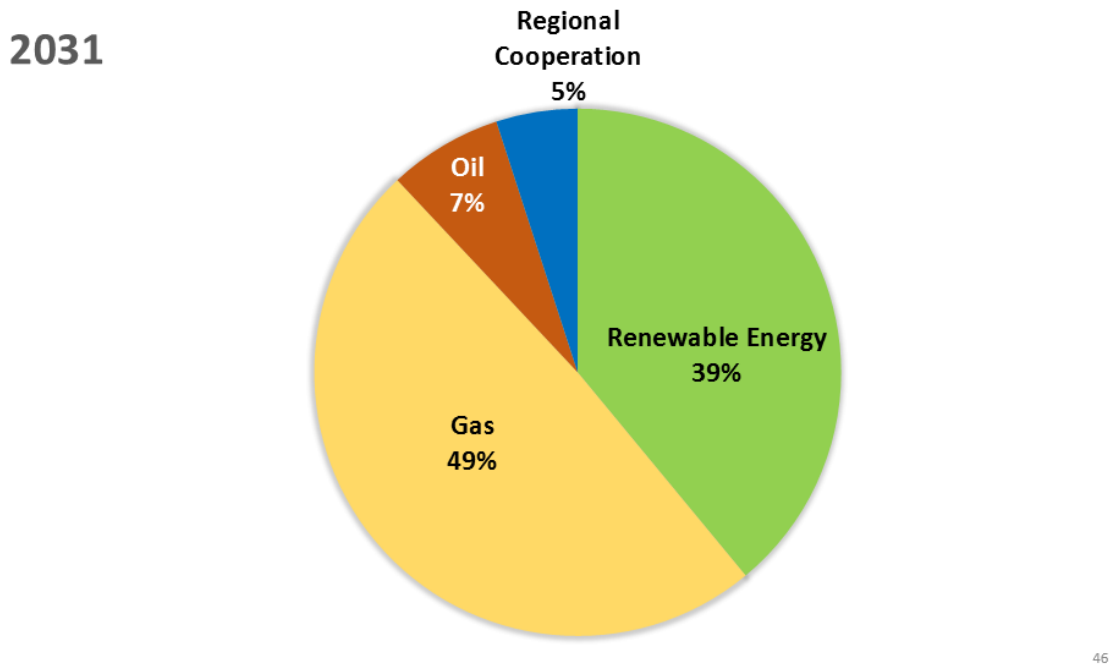


National Committee proposes minimal changes in the existing structure for electricity production in the short term (till 2021). Within this time, it is crucial to realize National Committee's 7 point demands (Appendix-2) including institutional and policy level changes, and institutional development to advance the use of renewable resources.

By 2021, National Committee's proposed structure calls for 59% electricity production from natural gas, 19% from oil, 10% from other sources (5% solar, 3%wind, 2% biofuel), and 7% from regional cooperation.

National Committee Proposed Midterm Energy Mix Plan (till 2031)

Figure 15:



In the midterm, as gas reserves from old gas fields will slow down, sufficient gas exploration activities in the shallow and deep sea blocks will be required. Meanwhile, the institutional and social capacity to use renewable resources is expected to be increased at a rapid pace. The institutional and policy foundation created in the short term will assist to achieve the qualitative change in the power sector in the midterm.

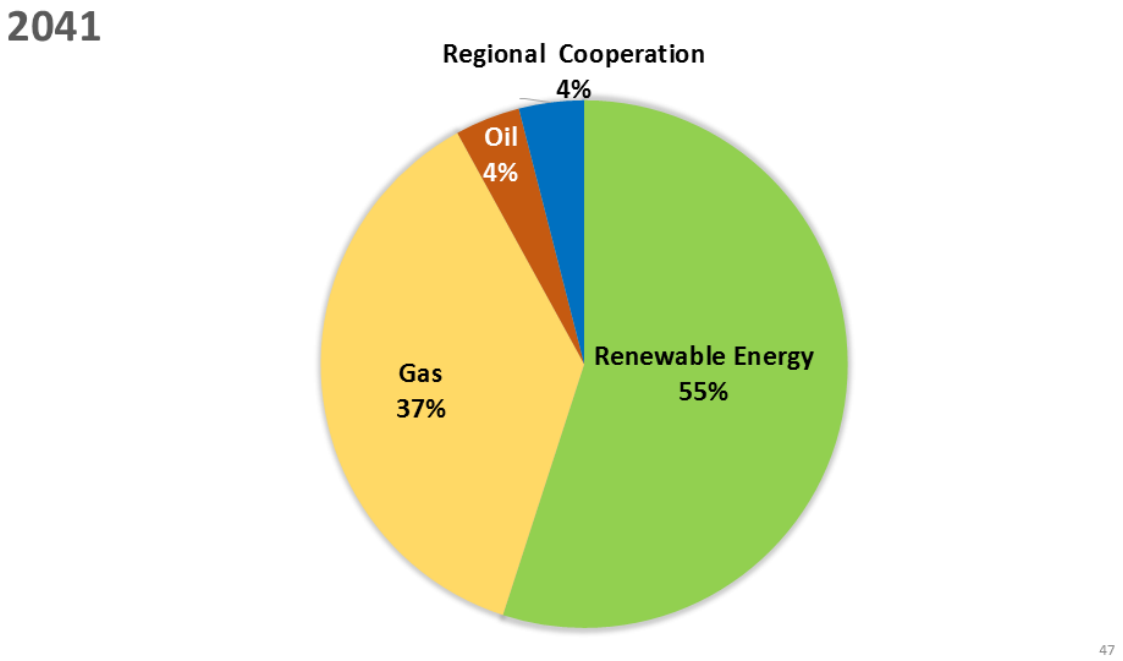
By 2031, gas based electricity will remain at the top, which is 49%.

Other sources are placed as follows: Different sources of Renewable energy: 39% (27% solar, 7% wind, 5% biofuel).

Oil and regional cooperation:12%.

National Committee proposed Long Term Energy Mix Plan (till 2041)

Figure 16:



By 2041, National Committee's proposed plan calls for 37% electricity production from natural gas, 55% from renewable energy (42% solar, 8%wind, 5% waste), 4% from oil, and 4% from regional cooperation.

Comparative View of Government Master Plan and National Committee's Master Plan

Topic	Government Program [33]	National Committee's Alternative Proposal
Goal of Electricity Production till 2041	245 TWh, 57000 MW(highest)	245 TWh, 57000 MW(lowest)
Main characteristic	Import-centric. Heavily Debt-dependent. Ecologically destructive.	Dependent on national resources. No dependence on debt. Ecology-friendly.
Main source of electricity production	Coal, LNG, Nuclear energy.	Natural Gas and Renewable Resources.
Main driving force	Foreign firms, financial institutions, consultants.	National agencies, local institutions, and public initiative.
Short term goal (till 2021)	Total: 23500 MW. Natural Gas: 34%, LNG: 11%, Coal: 30%, Oil: 15%, Importation: 10%, Renewable Resources: 0%.	Total: 25250 MW. Natural Gas: 59%, Oil: 19%, Renewable Resources: 10%, Others: 12%.

[33]GOB. "The Study for Master Plan on Coal Power Development in the People Republic of Bangladesh." PSMP 2016. Prepared by JICA. 2016. p. 7-26, 11-33

Midterm goal (till 2031)	Total: 34500 MW. Coal: 26%, LNG: 17%, Local Gas: 13%, Import/ Renewable Resources: 15%, Nuclear Energy: 14%, Oil: 15%.	Total: 49700 MW. Natural Gas: 49%, Renewable Resources: 39%, Others: 12%.
Long term goal (till 2041)	Total: 57000 MW Coal: 35%, LNG: 23.7%, Local Gas: 11.3%, Import/Renewable Resources: 15%, Oil: 5%, Nuclear Energy: 10%	Total: 91700 MW Renewable Resources: 55%, Natural Gas: 37%, Others: 8%.

Cost Comparison

The government's PSMP has proposed a total investment of USD 129.16 billion by 2041 in the power and energy sector of Bangladesh. In comparison, National Committee has proposed an investment plan requiring a total of USD 110 Billion. It is important to note that the government proposed electricity tariff is observed to be almost double the electricity tariff proposed by the National Committee.

A Comparative Picture of Average Electricity Tariff (in BDT; 1 USD = 80 BDT)

Year	**Government proposed per unit electricity tariff rate (average tariff in current price)** [34]	**National Committee proposed per unit electricity tariff rate (current price)**[35]	**Government proposed average tariff in nominal price (2015 price rate)**	**National Committee proposed average tariff in nominal price (2015 price rate)**
2021	11.56	7.65	8.52	5.23
2031	31.94	20.07	11.02	5.29
2041	79.14	50.19	12.79	5.10

Source: Power Sector Master Plan 2016 (page 21-4) and NCBD Expert Panel Analysis

[34]estimation based on figures provided in PSMP 2016, Government of Bangladesh.
[35]detailed analysis is provided in the full version of research document.

Concluding Remarks

The current development philosophy, based on corporate profit with high social and environmental cost, encourages privatization of common property, land grabbing, special economic zones, urbanization, consumerism, large scale coal plants and nuclear plants. Such economic models cause destruction of agro land, fertility loss, crop loss, damage to eco-system and fish production, health crisis, eviction of communities and rural to urban migration. Our proposal asks to change this developent model.

We need to go forward with development vision that put people before profit, that protect environment to protect our present and future, that keep public interest over corporate interest, that goes with maximum transparency and accountability. Our proposed plan aims at realizing that vision. Let us work together to make it happen.

Appendix 1

A Proposed Model for Solar based Electricity in Rural Areas:

This section is prepared based on various questions and confusions related to the potential of rural based solar electrification in Bangladesh. The section will briefly discuss the following:

- The possible role of both state and private actors in the installment and expansion of solar projects in the rural areas
- The commercial viability of village based solar electrification
- The prospect of solar based local industrialization

Role of Different Actors

The possibilities of both state and non-state actors' involvement in the solar energy projects are multifaceted. It is commonly known that the private companies are generally interested in large-scale or utility-scale solar power projects. In general, 10 KW to 20 KW solar projects are not perceived as financially lucrative for big companies. Thus, the chances for large solar companies investing in rural areas are not so great. In this context, state institutions can play a key role in building solar power projects at the village or sub-district level. Individual investors, cooperatives, different business entities, small or medium companies, and grass root organizations could also be major actors in setting up solar projects.

In the rural areas, solar panels can be set up in a number of places: river banks, paddy fields, shallow wetlands, road lanes, and empty rooftops of schools, religious institutions, local union councils, courts, police stations, public health complex, and UNO office. It is to be noted that solar panels are commonly set above the irrigation canals in India. Same could be applied in Bangladesh.

There are several ways through which various state actors may play important roles in the installation and expansion of solar based projects in the rural areas. For instance, Power Development Board and Rural Electrification Board[36] of Bangladesh Government could make long term contracts (20-25 years) with the registered owners of rural lands (It is common for the mobile companies in Bangladesh to make long term agreements with city landlords for installing mobile towers in rooftop spaces). Different business establishments, small or medium investors, grass root organizations or co-operatives can also make similar contracts with land owners (both government-owned or community owned lands). Land lease agreements could be determined through mutual consent of two parties.

[36]The state owned institutions such as REB (rural electrification board) operate in the rural areas for the purpose of power generation and distribution.

Solar produced electricity could be used/ distributed in a number of ways:

1. After meeting up the household/local demand, surplus electricity can be sent to the National Grid.
2. Mini-grid/Micro-grid: Produced electricity can be used up by the consumers.

As finding investors for rural solar projects could be challenging in the initial phases, the issue of state subsidy becomes important (a brief discussion on subsidy is added in one of the following sections).

Realizing the potential of Rural-based Solar Electricity

To examine the solar potential of rural areas in Bangladesh, we need to re-assert the following information:

- There are approximately 87,000 villages in Bangladesh. On average, about 300-400 families live in each of these villages.
- Considering latest technology, 3 to 4 acres of land is needed to install 1 MW capacity solar installation.
- To install 53,000 MW of solar based installation by 2041,[37] about 2500 to 3300 acres of land area will be required from each district of Bangladesh (among 64 districts).

Assumptions:

- Let us assume that 50% of total electricity of Bangladesh will be generated exclusively from the rural areas, while the rest could be achieved from urban centers of the country (The rate of urbanization is not included in this assumption).
- Let us also assume that each village will produce 300 KW of electricity by 2041 (to achieve the target by 2041).
- Let us assume that government agencies, including REB, SREDA, IDCOL can take over around 50% of the proposed 300 KW electricity for a village (We recommend a gradual increase in the annual budget of these organizations).
- To produce the rest of the150 KW (50% of proposed generation requirement from each village) of electricity, the initiative of small and medium investors, NGOs, cooperatives and various private companies are important.

Investor types in accordance with installation capacity (KW)

Individual Investor	2, 3, 4, 5
Grass root organizations/cooperatives	5-20
Business/company	15-30

It is feasible to build different solar projects with varying production capacity (For instance, 2, 5, 10, 15, 20 or 30 KW).The investors will invest according to their financial ability. It should be

[37]Required installed capacity of solar by 2041 (estimated by National Committee Research Panel)

also kept in mind that each village will gradually build its solar capacity (the proposed 300 KW) throughout the time period of around 20 to 25 years. It is only by the year of 2041, 300 KW of electricity is targeted to be achieved.

Time Frame and Village-based target of solar electrification

By the year 2021	10 KW
By the year 2025	30 KW
By the year 2031	100 KW
By the year 2041	300 KW

It is to be noted that with the gradual expansion of solar based electrification, the range of economic activities in the rural areas will expand itself. The growth and extension of economic activities will cyclically push rural communities to achieve the target of 300-400 KW of solar electricity by the year of 2041. To materialize this model, it is expected that the government would provide support for capital investment, low interest loan, tax waivers, and a guaranteed purchase of produced electricity.

Is a village-based Model for Solar-based Electrification Financially profitable?

It is already discussed that finding investors for rural solar projects could be challenging in the initial phases without the provision of state subsidy. For the gradual expansion of solar based electricity, 4 different types of state incentives are recommended. Similar state assistance also applies for the city-rooftop based urban solar electrification.

Investment Assistance on Capital Investment: The Indian government has long provided a 30 percent subsidy to the private investors and household users as initial capital investment. Currently 40% initial subsidy is already provided for the mini Grid solar projects located in the non-Grid remote areas of Bangladesh.[38] In the context of Bangladesh, an appropriate investment assistance package on capital investment could be announced by the government in order to reduce the burden of the private household actors in installing solar projects. Private investors as well could be provided with capital incentives in order to speed up the expansion of solar power projects.

Bulk Tariff: It is to be noted that Bangladesh Power Development Board purchases per unit of electricity at 6.50 taka. A flexible tariff rate could be proposed from the part of the government (subject of discussion) as a financial incentive (could be ranging from 1taka to 4 taka) to the solar producers. It should be also noted that the price of solar panels and related technologies are falling at a drastic rate. In this condition market scenarios should be reviewed in regular intervals and the tariff rate should be gradually reduced.

Tax Waiver: Solar producing companies in general receive various tax waiver facilities as financial incentives from the part of the state. In the context of Bangladesh, investors producing

[38] Infrastructure Development Company Limited, Bangladesh Green Banking Policy. Page 4. Retrieved from http://idcol.org/download/Green_Banking_Policy_for_IDCOL.pdf,

from 30 kW to 200 kW of electricity could be given a tax relief for at least 3-5 years (subject of discussion).

Provision for low interest loan*:* At present, IDCOL provides loans to solar entrepreneurs at a 6% interest rate.[39] According to various experts, the government banks can offer up to 30 to 40 percent of the initial capital investment with low-interest loans (subject of discussion).

Land Facilities: The state may also transfer its abandoned land to the private investors for the installment of solar projects.

Our detail financial analysis shows that considering various subsidy including capital cost incentives, tax adjustments and tariff incentives, investors of solar projects would be able to recover their initial investment cost within a time frame of 4-5 years (see full report).

The Subsidy Debate

A widespread conception prevails that expansion of solar-based power generation would require massive state subsidy which might not be economically feasible for a developing country's government to take over. However, two important facts are ignored while discussing this issue of subsidy.

a. The conventional power generation process based on various fossil fuels is heavily subsidized in most countries of the world. Heavy pollution caused by Coal power plants also leads to the provision of massive state subsidy to the public health sectors of different countries.

b. As the price of solar technology is falling at a drastic rate, the required amount of subsidy will naturally fall within five years from the inception. For instance, with the rise of efficiency and fall of the price of solar cells, Germany has gradually reduced its solar subsidy to a minimal level. In case of India, a 30 percent subsidy is only given to the rooftop installers. On the other hand, Indian utility scale solar plants have become competitively profitable and participating in reverse bidding without the provision of any state subsidy. Currently in India solar power producer are offering solar electricity for BDT 3/kWh and wind electricity for BDT 4.2/kWh only.[40] In this context, provision of different layers of state subsidy to the renewable energy based power production process remains an economically rational choice.

What is the actual demand of electricity in the rural areas? How to solve the issue of surplus electricity in case of inadequate demand?

In general, the demand for electricity in the rural areas of Bangladesh is comparatively low. There is very small demand throughout the day. It is only after the evening time the use of electricity (mostly light, television, and fan) picks up. As surplus electricity in the remote (grid-

[39] The lending terms for the solar mini and micro grid projects. Available At: http://idcol.org/home/r_lending_terms

[40] Website of Ministry of New and Renewable Energy India, http://www.mnre.gov.in/, accessed on 15 Oct, 2017.

less) areas cannot be sent back to the national grid, the solar companies operating the mini grid systems experience the crisis of over production.

What is The Solution to This Problem?

It is quite an ironic situation. In one hand, a serious national power crisis has been persistent for long. On the other hand, mini grid investors are failing to sell their surplus electricity in the locality. Seemingly the demand for electricity is inadequate in the rural areas. The lack of rural demand for electricity raises some valid concerns.

Urban facilities are missing in the rural areas. Due to a poor grid system and inadequate supply of electricity, most rural residents do not own basic electronic products and gazettes, including televisions, refrigerators, or computer/laptops. Even the financially solvent portions of the rural areas are deprived of aspirational facilities. Due to lack of electricity, rural economic activities do not get to expand, and unemployment remains high. The scenario represents a classic case of "UNMED DEMAND", in which, a demand for electricity is persistent (which could be entirely met through solar power), however, as a result of a flawed development planning, the actual potential for rural economic activities remain unexplored.

Prospect of Local Resource Management and Local Industrialization

It is needed to be asserted that solar energy should not be just perceived as a mere medium of electricity generation. The possibilities of revitalizing the stagnated rural economies could be unleashed through gradual expansion of renewable energy. In the presence of a vibrant economic life, the need for rural to urban migration will also be diminished. The possibilities of a number of economic activities are described here which can be generated through the gradual expansion of solar based electricity in the rural lives:

1. Solar based Irrigation: Most irrigation projects in the village are run by Diesel. Currently, about 600 solar based irrigation pumps have been established under the supervision of the government agency IDCOL.[41] Solar based irrigation has the potential to entirely replace Diesel-run irrigation, which would also save the cost of diesel subsidy.

2. **Crop drying**: Almost 20% of farmers' produce in India and Bangladesh, including potato, tomato, pies, and onions are damaged due to heavy moisture. This could be easily prevented through the solar drying system. It is possible to save about 20% of the crop if the process of solar based 'crop drying' is implemented.

3. Cold storage: In the absence of adequate cold storages in Bangladesh, farmers are forced to sell their crops and vegetables at a low price. Due to frequent power cuts in the rural areas, solar based cold storages are specifically suitable for farming villages.

4. Local industry: Large scale industries require large scale land acquisition and eviction of communities. It also leads to loss of agricultural land and various level of pollution. However,

[41]IDCOL. Available at: http://idcol.org/home/solar_ir

expansion of renewable energy based economic activities opens up opportunities for local industrialization. Some of these rural based industries include: rice mills, fish processing plants, ice factories, fruit drying factories, dairy products, jute products etc.
Local resource management and local industrialization which exclusively focuses on the need of the communities, while avoiding elements of pollution and wastage is becoming more relevant today. Renewable energy based rural electrification could be the most crucial driving force for local industrialization in Bangladesh, contributing to rural employment and a dignified standard of living for the people in general. The additional prospects of biomass and wind will gradually add to the total estimation of our rural based models.

Appendix 2

7 Point Demands of National Committee:

- Ensure peoples ownership of natural resources. Stop privatization of common property.
- Cancel immunity to power projects, take actions against officials, consultants and politicians responsible for taking disastrous path of 'development'.
- Prohibit export of natural resources for its necessary utilization.
- Stop signing production sharing contracts to ensure utilization of natural gas for power generation. Reclaim compensation (nearly US$5 billion) from Chevron and NIKO for blowouts.
- Implement Phulbari agreement including banning open pit mining and oust GCM.
- Improve national capability for energy security and sustainable development.
- Develop human resources and institutions to make renewable energy as mainstream source of power and energy.

Appendix 3

Berlin Declaration

During the European convention on Sundarban held in Berlin, Germany (August, 2017) a unanimous Berlin Declaration has been signed by more than hundred globally operating organizations in support of the NCBD proposed Alternative plan, while urging Bangladesh government to scrap Rampal coal fired power plant immediately to save sundarban.

We, the participants of the Sundarbans Solidarity Action Networking and An Alternative Energy Solutions for Bangladesh, organized by The National Committee to Protect oil, gas and mineral resources power and ports in Bangladesh, European Action Branch on 19-20 August, 2017 in Berlin have accepted the declaration as below:

The Sundarbans, the largest mangrove forest in the world, is bestowed with magnificent scenic beauty and extraordinarily rich biodiversity with a unique eco-system. It is a habitat of some of the endangered species e.g. Bengal Tiger, Ganges dolphin. People living in adjacent areas

are also dependent on this forest. Besides providing livelihood, it is also protecting millions of people living in the coastal belt from tidal surges and cyclones.

This forest is under severe threat from a Bangladesh-India joint venture project– Rampal Power Plant, a coal based power generating company. The plant is placed only 14 km from the forest. It is estimated that the plant will emit 7.9 million tons of CO2, and 0.94 million tons of ashes annually which will contaminate environment of the adjacent areas and will put the intricate ecosystem into perilous condition. Despite the grave concerns raised by the experts, scientists, environmentalists, local population, and international organisations, the Government of Bangladesh has been working to implement the project for the last seven years.

The project is scheduled to be completed within next one year or two. To justify the project the government is blatantly giving false assurances to protect the forest from all sorts of adverse impacts. The Government of India is also a major stakeholder in this joint-venture project and playing important roles as consultant, financier, and supplier of the equipment.

There is a growing demand for electricity in the country. To address the demand, the government has adopted a Power Sector Master Plan (PSMP) in 2016. The plan has proposed that the use of coal would increase from the current 0.3% to over 35%. The coal-fired power plants would produce electricity worth of 19,000 MW. It has also set the target to meet 10% of its electricity demand, by 2041, from its 7000 MW nuclear fleet, undermining the renewable energy potential. According to the PSMP 2016, the contribution of renewable energy would be only 3% of total electricity generation by 2041. This suggests that the government's plan has failed to address environmental concerns and technical development in regards to renewable energy sources. Environment-friendly renewable energy solutions are sustainable and cost effective and because of this, many countries in Europe and Asia including India and China are moving away from coal and nuclear-based power generations. On the other hand, ignoring the current trend, the government of Bangladesh has taken a position in support of coal and nuclear-based power generations.

National Committee to Protect Oil, Gas, Mineral Resources, Power and Ports (Bangladesh) has proposed an Alternative Power Sector Master Plan (APSMP) in July 2017. The APSMP 2017 has proposed to generate 55% of electricity from renewable energy sources including solar, wind, waste etc. by 2041. National committee also insists on building the national capability to attain 100% renewable energy usage to meet electricity demand by 2050. It has also categorically refuted the government's arguments in regards to the nuclear and coal dependent energy policy.

We demand the government to listen to the clean energy movement and protect people's interest rather than corporate interest. As renewable energy is cheaper and eco-friendly, we demand policy shift emphasizing renewable energy production rather than dirty coal energy generation. Renewable energy will protect ecology, life and livelihood of the people. The government must take appropriate steps to phase out coal and replace it with renewable energy sources. As a coal based power plant, Rampal Plant will irreversibly damage the Sundarbans. It will disrupt the link between humans and the environment by destroying ecology and species. This conference unequivocally demands the immediate halt of the plant. We urge everyone to raise their voice to save our Sundarbans, and to save our future.

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