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Feasible Micro Hydro Potentiality Exploration in Hill Tracts of Bangladesh

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Abstract - The energy demand is expected to grow rapidly in most developing countries over the next decades. For Bangladesh, economic growth has been accelerating and it is expected that the population will grow from an estimated 162.20 million people in 2011 to 200 million by 2050, with almost half of the population living in urban areas. For meeting the expected energy demand as the population will rise and to sustain economic growth, alternative form of energy – renewable energy needs to be expanded. This paper tries to explore the possibility of finding the renewable energy mainly from micro hydro in different places of Chittagong hill tract region by thoroughly describing present condition of energy along with data collection, calculation and feasibility of power generation from July 2011 to Jan 2012.

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I. Introduction

The development of a country is mostly dependent on per capita energy use. Bangladesh is one of the poor countries in the South Asian region. A large number of its population is out of electricity. Only 48.5 percent of the total population has access to electricity [5]. Most of the power generation of Bangladesh is based on fossil fuel sometimes which is playing a negative impact on finance in the long run operation. So to supply the electricity to the rest people is a great challenge. In future fossil fuel will not be able to supply the electricity to the user as it will be finished & not environment friendly also. So to search and depend on environment friendly renewable energy is now a great desire of the country. Bangladesh has a great probability of renewable energy. It has much different form of renewable energy resources. Among them micro hydro may play a major role specially to serve electricity in the remote area of Chittagong hill tract for ensuring economic growth of the country. Though a great potentiality of micro hydro to serve power in remote areas but real feasibility of implementation of this type of power generations are still behind limelight. Development of micro-hydro power plant can reduce electricity scarcity problems so economically in remote areas of Chittagong Hill Tract without any major hassle.

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II. Present Power Scenario Of Bangladesh

In the South Asian region Bangladesh is one the most densely populated country (1099 people/km^2 in 2010) [7]. With high population Bangladesh is experiencing extreme energy challenges especially for the shortage of electricity. Shortage of electricity may be considered in two forms firstly, reviewing the scenario of per capita electricity consumption and percentage of population having access to electricity in Bangladesh compared to other countries and secondly, determining gap between demand and supply of electricity in perspective of country's economic situation and GDP growth. By the dichotomy of power generation and demand Bangladesh faces a severe load shedding. Bangladesh relies greatly on fossil fuels for its energy, but the present reserve would be depleted by the year of 2015[7].

Table 1 : Rate of use of different types of energy in producing electricity.

Fuel	Percentage of use (2010)
Furnace oil	2.81
Diesel	1.75
Hydro	3.39
Coal	3.77
Gas	88.29

a) Production of Power in Bangladesh

Bangladesh Power Development Board (BPDB), Ashuganj Power Station Company Limited (APSCL), Electricity Generation Company of Bangladesh (EGCB) is producing electricity in the public sector. On the other hand, through IPP (Independent Power Producer) and through Rental electricity is produced in the private sector which is purchased by the Government at a fixed rate [8]. At present nearly 54.40 percent of total electricity production is produced from public entities. BPDB alone produces 43.51 percent of total electricity production [5].

Table 2 : Statistics of electricity production in Bangladesh (March, 2012).

Sector	Organization	Power Generation (MW)	Total
Government	BPDB	3483	4355
	APSCL	662	
	EGCB	210	
Private	IPPs	1272	3650
	SIPP	225	
	Rental (15 years)	168	
	Rental (3/5 years)	1885	

b) Future power production Plan of Bangladesh

Bangladesh government has taken a long term plan to develop the power sector and mitigate the present power scarcity. According to the plan Electricity Generation in the country by 2013 will be 8500 MW and within 2015 this generation will rise to 11,500 MW and surplus power will be possible to give to national grid. Within the year of 2021 there is a plan to generate 20,000 MW power and to provide power to the whole area of the country [4].

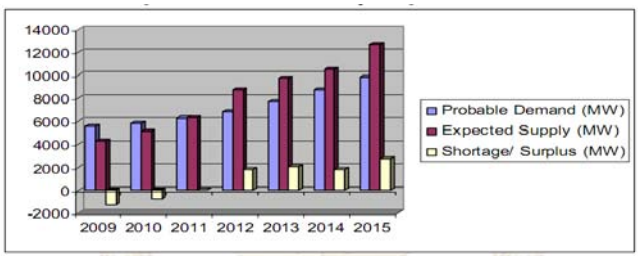

Fig. 2 : Probable power shortage/ surplus of Bangladesh (2009-2015).

Table 3 : Year wise expected power generation statistics of Bangladesh Power Division.

Year	Government Sector	Private Sector	Total
2010	360	432	792
2011	920	---	920
2012	505	1764	2269
2013	725	950	1675
2014	1170	---	1170
2015	---	2600	2600
Expected Extra Generation			9426

In last few years to meet up the scarcity of power so quickly government has taken some short term steps and thus establish quick rental power plant. So far, as many as 18 quick rental power plants have been approved and 14 of them are operational now. To fuel these power plants, the additional cost for the current fiscal year, as projected by the World Bank is between Tk. 52 billion and Tk. 56 billion, which is about 0.6 per cent or 0.7 per cent of the Gross Domestic Product (GDP)[1]. Excess payment for quick rental power plants has already affected various government economic decisions and posing a serious threat to the economy. For this reason the topic to quest and establish renewable energy based power plant come to forward. So this paper has a little effort to meet the demand of searching that renewable energy sources and supply power to some remote areas.

III. Renewable Energy Scenario Of Bangladesh

a) Solar Energy

Bangladesh is located between 20.30 to 26.38^0 North latitude and 88.04 to 92.44^0 East which is an ideal location for solar energy utilization. Here, the daily average solar radiation varies between 4 to 6.5 kWh per square meter. Infrastructure Development Company Limited (IDCOL) has supported NGOs in installation of Solar Home Systems (SHSs) and a total of 801,358 SHSs having capacity of about 36.5 MW have been installed till January 2011[6]. About 10 kW central AC solar PV systems have been installed in one selected market in each of the three Rangamati district's sub-districts [3].

b) Wind Energy

In Bangladesh, especially at coastal areas there are some Islands where wind energy can play a very important role to progress the economy of the country. BPDB installed a 160 feet tower at the Muhuri Dam site in the Feni district in May 2003. BPDB implemented a 1000 kW capacity wind battery hybrid power project (WBHPP) at the Kutubdia Island (Bay of Bengal) in the Cox's Bazar district. Under this project, total 50 nos. of 20kW capacity stand alone type wind turbines are being installed. The total capacity of all the wind turbines is 1 MW [9]. In another project, BPDB has implemented a 0.90 MW capacity of the Grid Connected Wind Energy (GCWE) at the Muhuri Dam areas in the Feni district in 2004 [3].

c) Biomass and Biogas

Biomass covers all kinds of organic matter from fuel wood to marine vegetation. Biogas is a mixture of CH_4 (40 to 70 %), CO_2 (30 to 60 %) and other gases (1 to 5%) produced from animal dung, poultry droppings and other biomass wastes in specialized bio-digesters [2]. In Bangladesh biomass accounts 70% of the total final energy consumption. IDCOL financed a 250 kW Biomass based power plant at Kapasia upazila under Gazipur district [9]. From 1971 to October 2009 About 41000 biogas plants has been constructed by different NGOs, under National Domestic Biogas And Manure Program (NDBMP) of IDCOL. Under NDBMP of IDCOL, 5688 biogas plants have been constructed in Bangladesh in the year of 2010 [9].

d) Hydro Energy

Kinetic energy from flowing or falling water is exploited in hydropower plants to generate electricity. In Bangladesh about 1.4 trillion cubic meters (m^3) of water flows through the country in an average water year. Major rivers of the country have a high rate of water flow of about 5 to 6 months during monsoon season which is substantially reduced in winter season. At present only 230 MW of hydro power is utilized in Karnaphuli, Rangamati hydro station, which the only hydro-electric power plant operated by BPDB [9]. Microhydro and minihydro have limited potential in Bangladesh, with the exception of Chittagong and the Chittagong hill tracts. Hydropower assessments have identified some possible sites from 10 kW to 5 MW but no appreciable capacity has yet been installed. Hydropower plants are classified into two categories:

1. Large hydropower plants (>10 MW), usually with reservoirs, that cannot only produce electrical energy Continuously, but also are able to adjust their output according to electricity demand.
2. Small hydropower plants (<10 MW) that are less flexible with respect to load or demand fluctuation due to their dependence on the water resource.

IV. Micro Hydro Potentialities In Bangladesh

The scope of hydropower generation is very limited in Bangladesh because of its plain terrains except in some hilly region in the North East and South East parts of the country. However there are lots of canals, tributaries of main river Karnafuli, Shangu, Matamuhuri as well as tiny waterfalls having good potentials for setting up mini/micro hydropower unit in Chittagong Hill Tracts (CHT) region. To explore potential sites of micro hydro; several studies have been conducted by Bangladesh Water Development Board (BWDB) and BPDB in 1981.

Table 4 : Potential Micro Hydro sites in Bangladesh.

District	Name of River/Stream	Potential Energy(KW)
Chittagong	Foy's Lake	4
Chittagong	Choto Kumira	15
Chittagong	Hinguli Chara	12
Chittagong	Sealock	81
Chittagong	Lungichara	10
Chittagong	Budia Chara	10
Sylhet	Nikhari Chara	26
Sylhet	RangaPani Gung	616
Jamalpur	Bi hugai-Kongsa	69
Jamalpur	Marisi	35
Dinajpur	Dahuk	24
Dinajpur	Chawai	32
Dinajpur	Talan at U/S	24
Dinajpur	Pathraj at Fulbari	32
Dinajpur	Tangon at D/S	48
Dinajpur	Punarbhaba	11
Rangpur	Buri Khora	32
Rangpur	Fulkumar	48

V. Micro Hydro Power Calculation

The amount of power available from a micro hydropower system is directly related to the flow rate, head and the force of gravity which can be derived by the following equation:

$$P_{th} = Q \times H \times g$$

P_{th} = Theoretical power output in kW, Q = Usable flow rate in m^3/s, H = Gross head in m and g = Gravitational constant (9.8 m/s^2)

VI. Micro Hydro Potentials Survey In Hill Tract Region Of Bangladesh

Greater Chittagong Region has a great geographical diversity and thus has a potentiality to get the micro hydro power. In last few decades several attempts have been made to find out the potential of micro hydro power generation. To explore the possibility of hydropower from small hilly rivers/streams in the country, a working committee was constituted on February 1981 with officers from Bangladesh Water Development Board (BPDB). A study was also conducted by a group of Chinese experts and by LGED in 2002-2003 [9]. This research has a goal to find some places according to mathematical scrutiny where the establishment of micro hydro is possible. Some places like Choto Kumira in Chittagong, Mahamaya Chora in Mirsorai, Chittagong, Ruangchori Canal in Bandorban, Sailopropat Spring in Bandorban have a great potentiality to establish hydro power plant. The feasibility of the establishment of micro hydro power generation has been corroborated by the following calculation.

a) Choto Kumira Canal, Chittagong, Bangladesh

Head, H = 3 ft = .9144m

Table 5 : Width survey of Choto Kumira Canal, Chittagong, Bangladesh.

No of Obserbation	Width (ft)
1	7
2	11.3
3	12.5
4	11
5	10.8

Average Width, W = 10.52 ft = 3.21 m

Table 6 : Depth survey of Choto Kumira Canal, Chittagong, Bangladesh

No of Obserbation	Width (ft)
1	2.2
2	2.7
3	2.4
4	2.6
5	2.8

Average Depth, D= 2.54 ft = .774m and Area = W×D = 3.21×.77 = 2.48m^2

For measurement of flow, passing the length of 13 ft or 3.96m following data were recorded.

Table 7 : Flow survey of Choto Kumira Canal, Chittagong, Bangladesh.

No of Obserbation	Time (Sec)
1	4.35
2	4.30
3	4.58
4	4.86
5	4.82

Average time, t = 4.58 sec,
Velocity, V = 3.96/4.58 = .86 ms^{-1},
Flow Rate, Q = V×A = .86×2.48 = 2.14 m^3/sec, Power, P = 9.81×Q×H = 9.81×2.14×.9144 = 19.19 kw.

b) Mahamaya Chora, Mirosorai, Chittagong, Bangladesh

Head, H = .9144 m, Width, W = 2 ft = .6096 m, Depth, D = 3 ft = .9144 m
Area = W×D = .6096×.9144 = .55741

For measuring the velocity we took the following data of time(t) to pass a distance of 16 ft.
Here, L = 16 ft = 4.88m

Table 8 : Velocity survey of Mahamaya Chora, Chittagong, Bangladesh.

No of Obserbation	Time (Sec)
1	4.72
2	5.03
3	4.8
4	4.95
5	4.86
6	5.07
7	5.05

Average time, t = 4.92 sec,
Velocity, V= L/t = 4.88/4.92 = .99 ms^{-1},
Flow Rate, Q = V×A= .99×.55741 = .5518359
Power, P = 9.81×Q×H = 9.81×.5518359×.9144 = 4.95 kw

c) Ruangchori Canal, Ruangchori, Bandorban, Bangladesh

Table 9 : Width survey of Ruangchori Canal, Bandorban, Bangladesh.

No of Obserbation	Width (ft)
1	69.5
2	65.3
3	89.1
4	77.7
5	82.5

Average width, w = 76.82 ft = 23.415 m, Average depth, d = 4.5 ft = 1.372 m and Cross sectional area, A = w x d = 32.12 m^2

For measurement of flow the passing the length of L = 1.2192 m following time were recorded

Table 10 : Time survey for flow in Ruangchori Canal, Bandorban, Bangladesh.

No of Obserbation	Time (Sec)
1	50.45
2	51.08
3	50.3
4	50.45
5	51.25

Average Time, t = 50.706 sec,
Velocity v = L/t = 1.2192/50.706 = .024 ms^{-1}, Flow, Q = V×A = .024×32.12 = .77088 m^3 /sec and Head, H = 5m.
Therefore Power, P = 9.81×Q×H = 9.81×.77088×5 = 37.81 kw

d) Sailopropat Spring, Sailopropat , Bandorban, Bangladesh

Head, H = 27.59 ft = 8.41m, Width , W = 2 ft = .61 m, Length , L = 4 ft = 1.2192 m
Area, A = W×L = .74 m^2

For measurement of flow the passing the length of L= 1.2192 m following time were recorded.

Table 11 : Time survey for flow measurement of Sailopropat Spring.

No of Obserbation	Time (Sec)
1	1.75
2	1.73
3	1.65
4	1.81
5	1.79

Average time, t = 1.74 sec,
Velocity, V = L/t = 1.2192/1.74 = .7ms^{-1}
Flow, Q = A* V = .74 *.7 ms^{-1} = .518m^3 /sec = 518 litre/sec
Power, P = 9.81 *Q*H = 42.74 KW

IX. Conclusion

There is a great potential of micro hydro in Chittagong hill tract region of Bangladesh. This paper shows some feasible places beside the government survey to establish micro hydro and generate power. There is a diversified geographical feature with hill, mountain, river, canal and spring exists in this region. This hill tract region has promising resources to play a great role in the economy of Bangladesh. But without abundant power and shortage of energy supply this promising resources can't be utilized. On the other hand it is so tuff to provide power from the national grid to the remote areas of Hill Tracts and it needs huge expenditure. So to provide the electricity in that region without extra expenditure it is very fruitful to establish the micro hydro power plant. This paper has an effort to bring the micro hydro power plant into limelight and also to show some new promising places with proper calculation where this kind of plant can be established. If it is possible to develop power plant using micro hydro then it will definitely change the overall scenario of electricity in these region which will certainly affect the life style and economic stability of the people in that region as well as Bangladesh.

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