CHITTAGONG UNIVERSITY CAMPUS: PERSPECTIVE OF HYDRO-ELECTRIC POWER GENERATION

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Abstract

Hydro-power is one of the most established renewable sources of energy for electricity generation. Hydro-power assessments have identified different possible sites for mini-micro hydro-power especially in the north, north-east and south-east regions of Bangladesh. In this research, an assessment has been made to find the possibility of mini-micro hydro-electric power generation by incorporating five charas available in Chittagong University campus. The collected data such as: flow of water, height of falling water & water reservoir during several times over the year shows the significant scope of mini-micro hydropower generation in the above mentioned area.

Key-words: Evaporation, precipitation, hydro-power, chara, identified, ecological, traditional energy, potentiality and sustainability.

1. Introduction

Energy is part and parcel of human life that has become a fundamental component of development activity. Bangladesh is regarded as one of the low energy utilisers and per capita energy consumption that is one of the lowest in the world, where at present 53% of total energy consumption is supplied from traditional fuels resources, with the remaining 47% from commercial sources [1]. Bangladesh, with its 160 million people in a land mass of 147,570 km^2 is an emerging economy of South Asia successfully maintaining sustained economic growth of least 8% since last decade resulted a considerable high electricity demand each year [2]. However, the demand could never been met due to inadequate generation addition in the past. For that reason, the load shedding has been increased day by day. The electricity generation in the country would be 20,000 MW by the year 2021[2].

To meet the expected energy demand with the increasing population and to sustain economic growth, renewable energy needs to be expanded. Hydro-electric power is the most efficient means to produce electric energy. Energy in falling water is converted into mechanical energy to meet the energy requirements for variety of tasks. Hydropower assessments have already identified some possible sites from 10 kW to 5 MW but no appreciable capacity has yet been installed, where the only one hydro power plant at Kaptai established in the 1960s with present

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installed capacity of 230 MW by 7 units, across the river Karnafuly [3-4]. Mini-micro-hydro-power have limited potential in Bangladesh with the exception of greater Sylhet, Rangpur, Mymenshingha, Netrakona, Sherpur, Chittagong, Rangamati, Khagrachari and Bandarban districts [3].

The famous institute Chittagong University is located at remote and hilly regions of Chittagong district. There are eight charas in the campus area where the water flow in a day is nearly steady but varies from season to season; during dry season it is minimum where in rainy season it is peak. An extensive study carried out for a mini-micro hydro-power generation on the five charas of Chittagong University campus by analyzing the collected data such as: flow of water, height of falling water & water reservoir in every two months over the year has been presented in this paper.

2. Hydro-Electric Power Generation

Water is a renewable resource that constantly recharged by the global cycle of evaporation and precipitation. Energy in water can be harnessed and used. Since water is about 842 & 855 times denser than air at 25^0C & 30^0C, can yield considerable amounts of energy [5].

Water flowing downstream is a powerful force. Hydro-electric power plants are the systems that generate electricity following the law of conservation of energy and the gravitational law. They are composed basically of a water reservoir, turbines, electric motor or generator, rotors & stators and channeling pipes. The mechanism of hydroelectric power plants follows the transference of kinetic energy of flowing water into mechanical energy of the blades when the water strikes with them forcefully. The movement of the blades is transferred to a generator which builds up a strong electric field thus producing electricity by the flow of electrons. This electricity is then transferred to the consumers via channeled vessels. Hydro-electric energy is a term usually reserved for large-scale hydro-electric dams. But on the basis of generation capacity hydro-power plants can be classified as: Pico-hydro: up to 5 kW, Micro-hydro: 5kW to 300kW, Mini-hydro: 300kW to 3 MW, small-hydro: 3MW to10 MW, Large- hydro: above 10 MW [3].

The three Gorges Dam at Hubei province of China is the world's largest power station in terms of installed capacity 22,500 MW that has 32 main turbines (each main turbine has a capacity of 700 MW) with two smaller generators (50 MW each) had been completed and fully functional as of July 4, 2012 [6-7]. The picture of the Three Gorges Dam of China as shown in fig.-1:

Fig. 1: Three Gorges dam of China the world's largest power station [7]

III. Current Status Of Hydro-Electric Power In Bangladesh

Bangladesh is a plain delta with having three of the world's major rivers the Ganges, the Brahmaputra and the Meghna flowing through it. The Jamuna-Padma-Meghna river system divides it into east & west and creates an average water flow of 1.3 trillion m^3 in a year throughout the country [3]. Many other rivers flow throughout the country which are actually the tributaries of these rivers. Out of all the rivers about 57 rivers are trans-boundary originating from India and Myanmar [3]. During monsoon the flow rate of most of the rivers is high but it reduces substantially during winter. Hence the scope of hydro-power generation is very limited in Bangladesh except in some hilly regions. However, there are a lot of tributaries, canals, tiny waterfalls which have good potential for setting up hydro-electric power plants. The only hydro power station of the country, the Karnafuly Hydro Power Station with a generating capacity of 230 MW by 7 units, is located in Kaptai, across the river Karnafuly which is generating 3% of total demand of the country [4, 8-9]. The first micro hydro-power unit of 10kW has been installed in a village of Bandarban through private initiatives which is providing electricity to 140 families in the village and to a Buddhist Temple [8].

Potential sites that have been identified from several studies are shown in table-I, II and III:

Table-I: The total hydro-power potential in Bangladesh has been summarized [9]

Description	Potential in MW	Already Harnessed in MW	Balance MW
The Karnafuli River Basin	330	230	100
The Sangu River Basin	87	-	87
The Matamuhuri River Basin	80	-	80
The Brahmaputra River Basin (a) Multi-purpose Project (b) Barrage Project	100 1,300	- -	100 1,300
Total=	**1,897**	**230**	**1,667**

Table-II: Micro hydro-power sites identified by sustainable rural energy (SRE) study in 2004 [3]

Site	Expected Power Generation (KW)	Socio-economic Infrastructure within 1 Km		
		House hold	School / Mosqjid/ Bazaar/ Clinic	Small Industry
Nunchari Tholipara, Khagrachari	3	100	3	1
Chang-oo-Para, Bandarban	30	200	5	2
Bangchari, Bandarban	25	600	12	5
Kamalchar, Rangamati	20	150	8	9
ThangKhrue, Rangamati	30	300	6	3
Monjaipara, Bandarban	7.5	50	3	-

Table-III: Potential small hydro sites identified from several study [3]

District	River/Chara/Stream	Potential of Electrical energy in kW
Chittagong	1.Foy's Lake	4
	2.Choto Kumira	15
	3.Hinguli Chara	12
	4.Sealock	81
	5.LungiChara	10
	6.Budiachara	10
Sylhet	7.Nikhari Chara	26
	8. MadhabCha-ra1500ft. from fall	78
	9.Ranga pani gung	616
Jamalpur	10. Bhugai-Kongsa at 2 miles U/S. of Nalita-bari P.S.	69 kw for 10 months; 48 kw for 2 months
	11. Marisi at Duka-bad near Jhinaigati Thana Head Quarter	35Kw for 10 months 20 kw for 2 months
Dinajpur	12. Dahuk at Burabari	24
	13. Chawai at U/S. of Chawai L.L.P	32
	14. Talam at U/S. of Talam L.L.P	24
	15. Pathraj at Fulbari	32
	16. Tangon at D/S of Nargun L.L.P	48
	17. Punarbhaba at Singraban	11
Rangpur	18. Buri Khora Chikli at Nizbari	32
	19. Fulkumar at Rai-ganj Bazar.	48

Power sector in Bangladesh has witnessed many successes stories in the last couple of years. The present of different renewable energies including hydro-power is shown in the fig.-2:

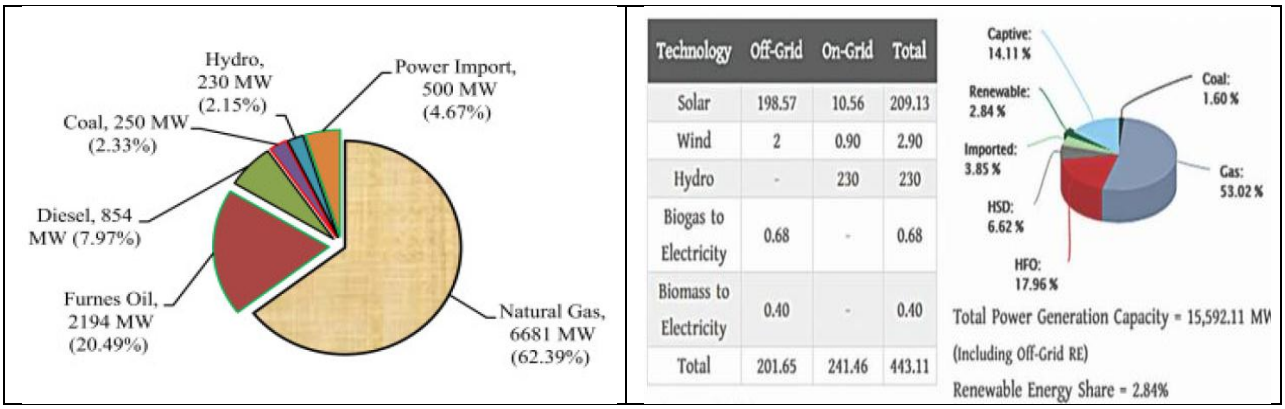

Fig.-2: Installed Capacity by different resources on 2017-18 [10-13]

In 1981 the Water Development Board and Power Development Board (PDB) carried out a study on the assessment of small/mini hydropower potential in the country. It identified 12 potential rivers/charas with an estimated annual production of 1.1 GW h in Chittagong-Bandarban area, 6.3 GW h in Sylhet and Moulovi Bazar area, 8.6 MW h in Mymensingh-Sherpur area and 1.8 GW h in the Dinajpur-Rangpur area [14]. Recently, Local Government Engineering Department (LGED) has taken up a project at Bamer chara in Bashkhali of Chittagong District; and Bangladesh Council of Scientific and Industrial Research (BCSIR) estimated that the potentiality of annual energy production of Sailpropat, Bandarban and in Madhobkundu, Moulovibazar is 43.8 MW h and 1.3 GW h, respectively [14]. In 1984, six Chinese experts visited Bangladesh for the identification of some potential sites to develop the mini hydro power plant and agreed with the above mentioned sites and added suggestion that Mahamaya Chara could be taken up for development of an integrated project for flood control, irrigation and power generation [14]. Barkal is one of the remote and un-electrified Upazila of Rangamati district (ranging 300-500 m in height); based on availability of water and electrical load demand of the adjacent area, Bangladesh Power Development Board (BPDB) proposed and designed a 20 kW micro-hydro power Plant [4, 14]. Besides these it has been assumed there are: Sangu project of Bandarban would be a new project of installed capacity of 140 MW with estimated annual energy of about 300 GW h per year; Matamuhari hydroelectric project would be a potential project of capacity 75 MW and approximate average annual energy 200 GW h per year [4, 14]. Some researchers have studied a channel in Halda River near Madhunaghat Bridge on the Chittagong-Kaptai road in the Chittagong district as prospective site for micro-hydro and Sapchari waterfall in Khagrachari hill district is near to the Sapchari village which is emerged out from Alutila hill range situated by the Chengi River [14-15].

IV. Site selection and Methodology

Chittagong University is with 1853.88 acre hilly land area where most of them are unused. Water is primary element for hydro-power. There are eight charas in the campus area where the water flow in a day is almost steady but varies from season to season; from November to April it is minimum but May-October it is maximum. Since the amount of water flow per unit time and the vertical fall of water are very important for determination of the generating potential of any hydroelectric power station. On that basis for this experimental study the selected five sites on different charas are: Site-I (Bottom of the chara at western side of University central field), site-II (Waterfall spot), site-III (Near registrar building bridge), site-IV [North campus switch gate made by (BPDB)] and site-V (Behind Forestry academic building). The spot pictures of selective five sites are shown in the figure-4. For the measurement of discharging water means flow rate (Q) Velocity-area method has been used at site-III and site-IV, Bucket method has been used at site-II and Float method has been used at site-I and site-V [11-13].

Fig. 4: Photographs of the five selected sites (Site-I, II, III IV and V) respectively

It has also been divided the year into six parts such as: (November-December, January-February, March-April, May-June, July-August, and September-October). The data has been collected ones

in a month from each spot but from May-September it is more than two. The average monthly precipitation in Chittagong district of Bangladesh over the year has been shown in the fig.-3:

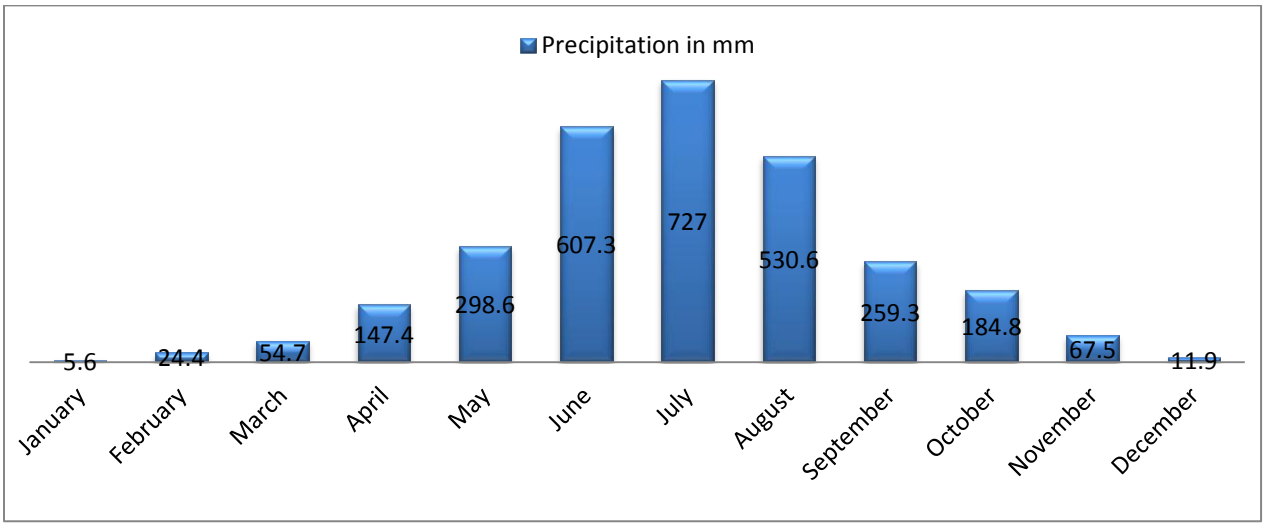

Fig.-3: Average monthly precipitation in Chittagong district of Bangladesh over the year (rainfall, snow) [16].

V. Results and Discussion

Calculation has been made from the collected data by using the general formula for any hydro-power system is: $P = \rho g Q h \eta$ Where, P = mechanical power produced at the turbine shaft (Watts), ρ = density of water (1000 kg/m^3), g = acceleration due to gravity (9. 81 m/sec^2), Q = flow rate [volume flow rate passing through the turbine (m^3/sec)] h = effective height in meter (m) [effective pressure head of water across the turbine] and η = hydraulic efficiency of the turbine (70%) [17]. Here, For Velocity-area method flow rate Q = Velocity of water (v) x area of cross section (A), where ($v = \sqrt{2gh}$) and A = width × depth (thickness) of flowing water; for Bucket method $Q = \frac{v}{t}$; and Float method $Q = v_{mean} \times A$ where, $v_{mean} \approx 0.85 \times v_{surf}$ [11-13]

From the experimental results graph has been plotted to show the possibility of discharge rate of water in the selected five sites per two months in a year shown in the figure-5:

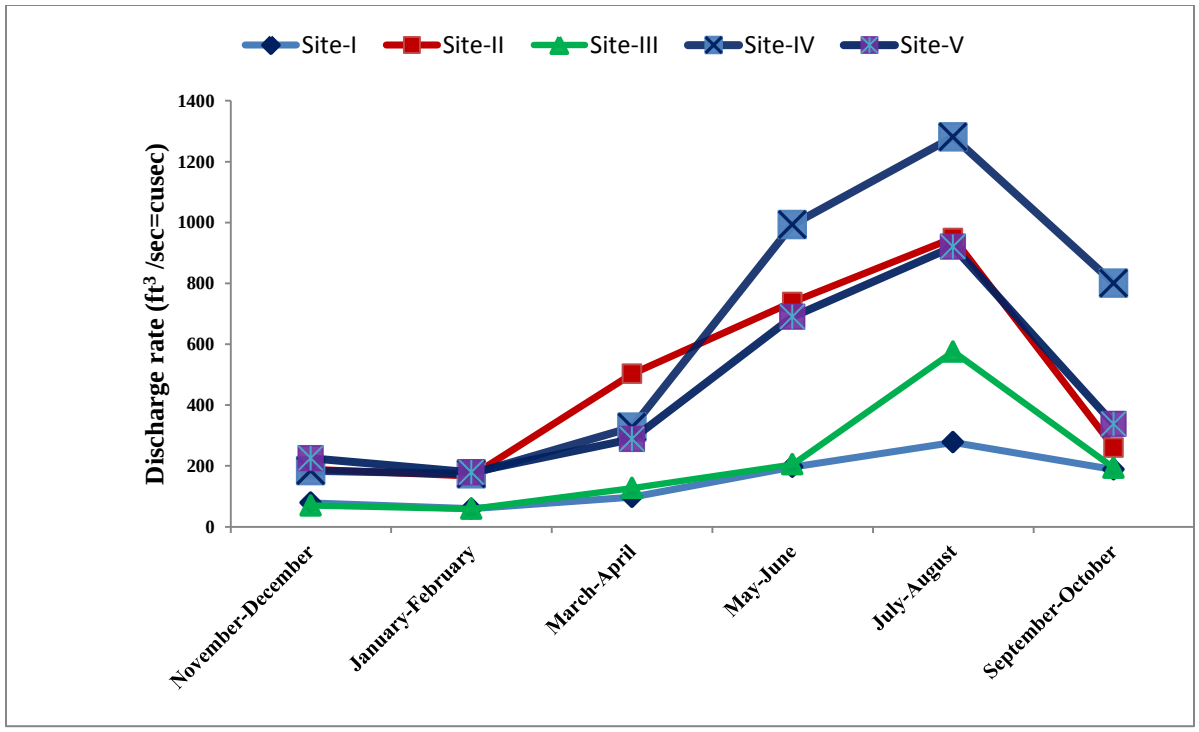

Fig.-5: Possible discharge rate of water at the selected five sites per two months in a year

From the discharge rate of water graph has been plotted to find possibility of power production in the selected five sites per two months in a year shown in the figure-6:

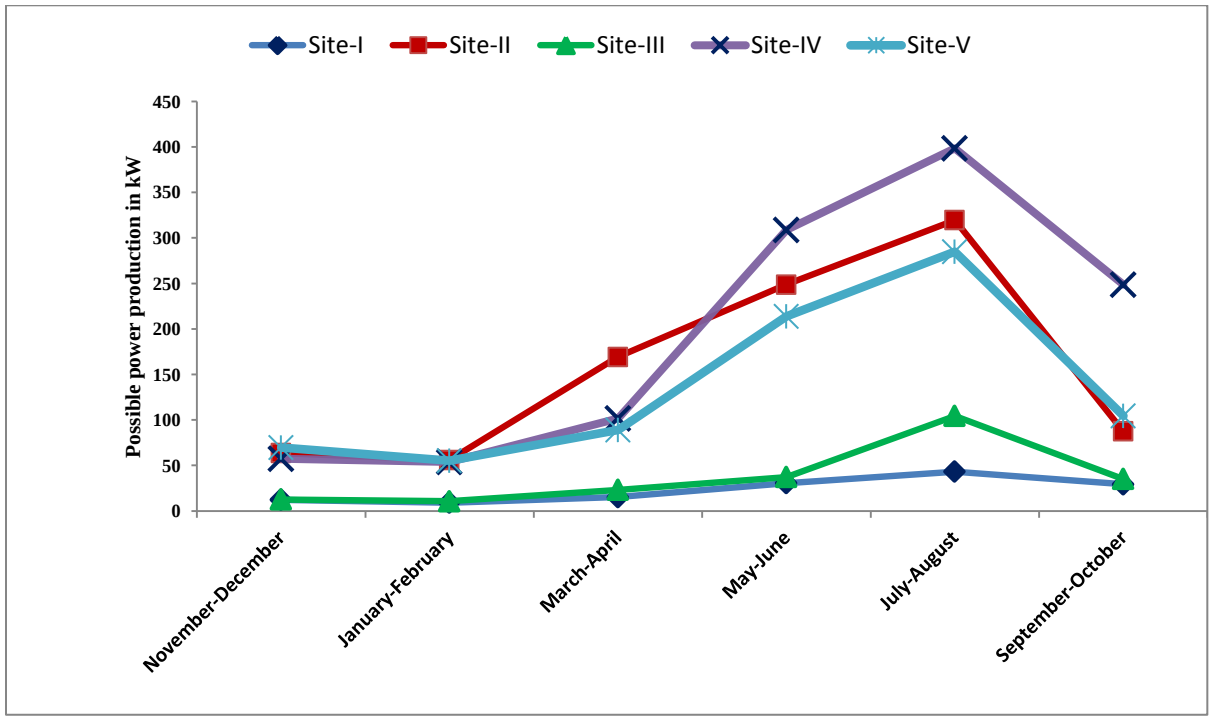

Fig.-6: Possibility of power production in five sites (individually) per two months.

Total possible power production capacity of five sites per two months shown in figure-7:

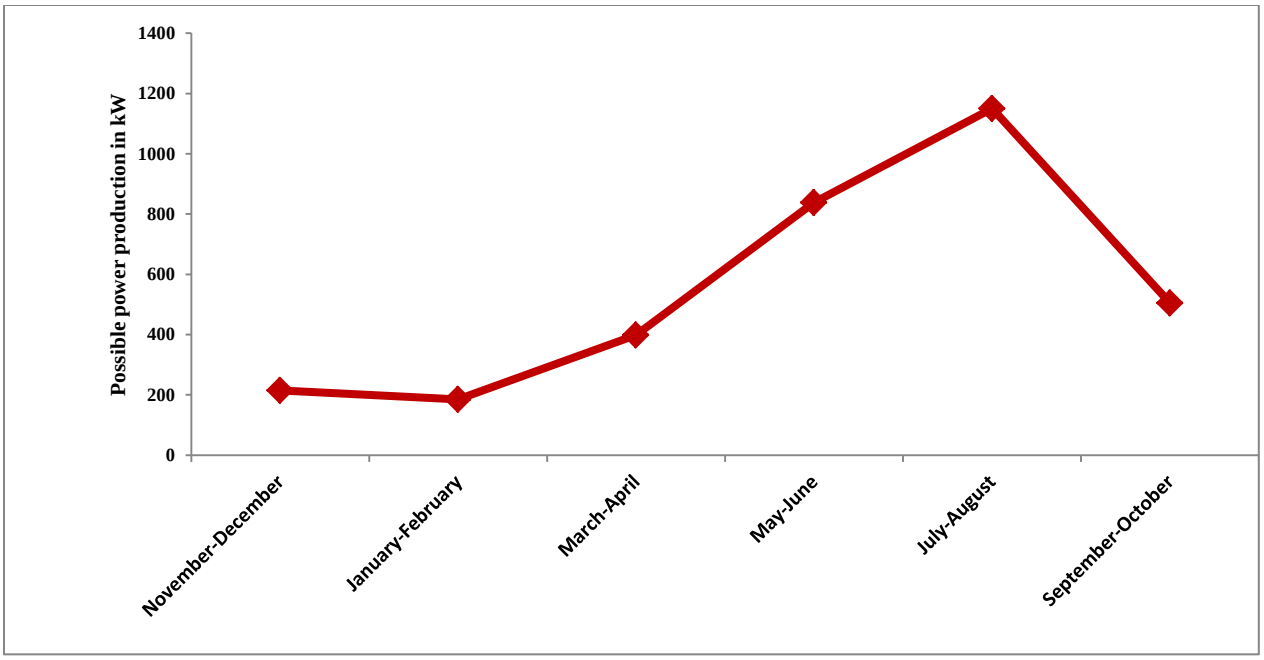

Fig.-6: Sum of the possibility of power production per two months by all selective sites

The above graphs indicate that the power production rate is increasing from month March-April and reaches to its peak value during July-August; then it starts to decrise again. This is only due to the water flow that increases from March-April and reaches to its peak value during July-August. The variation in the value may be of error in measuring the flow rate also. It is found that the maximum power generation is about 1150.347 kW during July-August and total possible power in the campus is 3292.50 kW. Moreover, there are huge space to construct reservoir in front of site-I, site-III, site-IV and site-V. The north campus switch gate (site-IV) constructed by BPDB that has spillways that are made up of heavy metal through which the flow of water can easily control as demand. Each spillway is 8 feet wide. From March to April two spillways and from June to October all spillways are open for discharging water. From November to February during winter people blocks all the spillways to irrigate the adjacent land and excess water pass through a bypass line.

VI. CONCLUSION

During dry season (November-March) the water flowing level wouldn't be zero; since, there are lots of tiny waterfalls in the charas. There is huge space to make reservoir for mini-micro types of hydro-electric power generation. Only proper management may give best result. If the authority consider the circumstances mentioned above and take necessary steps to produce hydro-electric power that can meet the University's power demand partially. Finally, it could be

concluded that, Chittagong University campus is prospective for the production of mini-micro hydro-electric power.

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