ISSN 1022-8594
JUJS

Vol. 42, No. 1, pp. 1-11

Possibility of Hydro-Electric Power Generation in Chittagong University Campus

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Abstract

Hydro-power is one of the most established renewable sources of energy for electricity generation. Several assessments have been 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 and water reservoir during several times over the year that shows the significant scope of mini-micro hydropower generation in the above mentioned area.

Keywords: Chara (tributaries or Hill stream), precipitation, hydro-power, traditional energy, potentiality and sustainability.

Introduction

Energy is the 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 where electricity demand increased day by day and it would be 20,000 MW by the year 2021[2].

To meet the expected energy demand with the increasing population, renewable energy needs to be expanded. Hydro-electric power is the most efficient to produce electric energy. Hydropower assessments have already identified some possible sites such as: greater Sylhet, Rangpur, Mymenshingh, Netrakona, Sherpur, Chittagong, Rangamati, Khagrachari

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and Bandarban districts of the country are potential for mini-micro type hydropower generation [3,4].

The famous institution Chittagong University is located at hilly regions of Chittagong district. 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 and water reservoir in every two months over the year has been presented in this paper.

Hydro-Electric Power Generation

Water is a renewable resource that constantly recharged by the global cycle of evaporation and precipitation. Since water is about 842 and 855 times denser than air at 25°C & 30°C, can yield considerable amounts of energy [5]. Water flowing downstream is a powerful force. Hydro-electric power plants are the systems that can 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 channel vessels. On the basis of generation capacity hydro-power plants can be classified as: Pico-hydro: up to 5 kW, Micro-hydro: 5 kW to 300 kW, Mini-hydro: 300 kW to 3 MW, small-hydro: 3 MW to 10 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 Figure-1:

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

Current Status of Hydro-Electric Power in Bangladesh

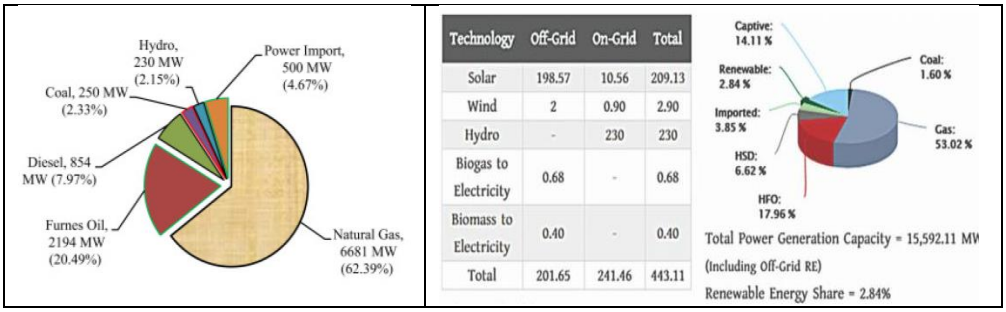
Bangladesh is a plain delta with having three of the world's major rivers the Ganges, the Brahmaputra and the Meghna flowing through it. Many other rivers flow throughout the country which are actually the tributaries of these rivers. Out of all the rivers about 57 rivers are trans-boundary originating from India and Myanmar [3]. During monsoon the flow rate of most of the rivers is high but it reduces substantially during winter. 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 established in the 1960s 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:

Table-I: The total hydro-power potential in Bangladesh has been summarized [3, 9]

Description	Expected Power Generation
The Karnafuli River Basin, Rangamati	330 MW (Already Harnessed 230 MW)
The Sangu River Basin, Rangamati	87 MW
The Matamuhuri River Basin, Rangamati	80 MW
The Brahmaputra River Basin, Greater Mymenshingh (a) Multi-purpose Project (b) Barrage Project	100 MW 1,300 MW
Nunchari Tholipara, Khagrachari	3 (KW)
Chang-oo-Para, Bandarban	30 (KW)
Bangchari, Bandarban	25 (KW)
Kamalchar, Rangamati	20 (KW)
ThangKhrue, Rangamati	30 (KW)
Monjaipara, Bandarban	7.5 (KW)
Foy's Lake, Chittagong	4 (KW)
Choto Kumira, Chittagong	15 (KW)
Hinguli Chara, Chittagong	12 (KW)
Sealock , Chittagong	81 (KW)
LungiChara, Chittagong	10 (KW)
Budiachara, Chittagong	10 (KW)
Nikhari Chara, Sylhet	26 (KW)
Madhab Chara1500 ft. from fall, Sylhet	78 (KW)
Ranga pani gung, Sylhet	616 (KW)
Bhugai-Kongsa at 2 miles U/S. of Nalita-bari P.S. , Jamalpur	69 KW for 10 months; 48 KW for 2 months
Marisi at Duka-bad near Jhinaigati Thana Head Quarter, Jamalpur	35 KW for 10 months 20 KW for 2 months
Dahuk at Burabari, Dinajpur	24 (KW)
Chawai at U/S. of Chawai L.L.P, Dinajpur	32 (KW)
Talam at U/S. of Talam L.L.P , Dinajpur	24 (KW)
Pathraj at Fulbari, Dinajpur	32 (KW)
Tangon at D/S of Nargun L.L.P, Dinajpur	48 (KW)
Punarbhaba at Singraban, Dinajpur	11 (KW)
BuriKhoraChikli at Nizbari, Rangpur	32 (KW)
Fulkumar at Rai-ganj Bazar, Rangpur	48 (KW)

Power sector of Bangladesh has witnessed many successes stories in the last couple of years. It has been presented different renewable energies including hydro-power in the Figure-2:



Technology	Off-Grid	On-Grid	Total
Solar	198.57	10.56	209.13
Wind	2	0.90	2.90
Hydro	-	230	230
Biogas to Electricity	0.68	-	0.68
Biomass to Electricity	0.40	-	0.40
Total	201.65	241.46	443.11

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

In 1981 the Water Development Board and Bangladesh Power Development Board (BPDB) carried out a study and identified 12 potential charas with an estimated annual production of 1.1 GWh in Chittagong-Bandarban area, 6.3 GWh in Sylhet and Moulovi Bazar area, 8.6 MWh in Mymensingh-Sherpur area, 20 KW micro-hydro power Plant in Barkal area and 1.8 GWh in the Dinajpur-Rangpur area for hydropower [4, 14]. Recently, Local Government Engineering Department (LGED) has taken up a project at Bamerchara 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 MWh and 1.3 GWh, respectively [14]. Besides these, Sangu project of Bandarban would be a new project of installed capacity of 140 MW with estimated annual energy of about 300 GWh per year, Matamuhari hydroelectric project would be a potential project of capacity 75 MW and approximate average annual energy 200 GWh per year [4, 14]. Some researchers reported that Halda River near Madhunaghat Bridge on the Chittagong-Kaptai road of Chittagong district and Sapchari waterfall of Khagrachari hill district are prospective site for micro-hydropower [14-15].

Site selection and Methodology

Chittagong University is with 1753.88 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 flow water (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].

Figure 3: Photographs of the five selected sites (Site-I, II, III IV and V) respectively

It has also been divided the year into six laps 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 Figure-3:

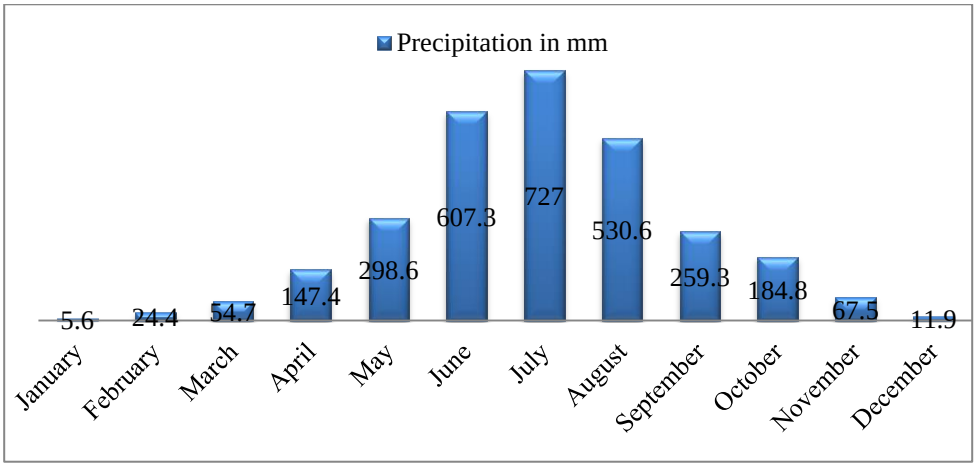


Figure 4: Average monthly precipitation in Chittagong district of Bangladesh over the year 2018 [16]

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:

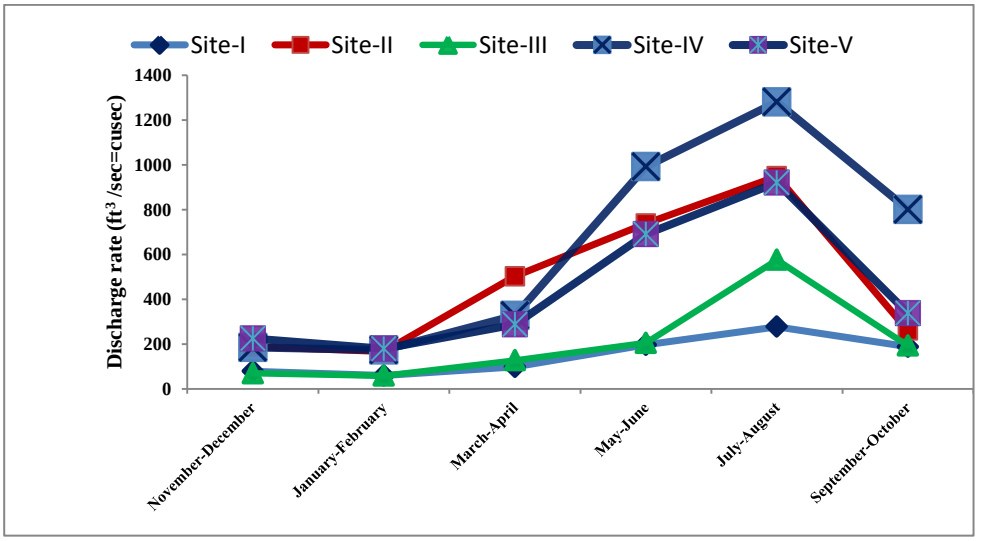


Figure 5: Possible discharge rate of water at the selected five sites per two months in a year

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:

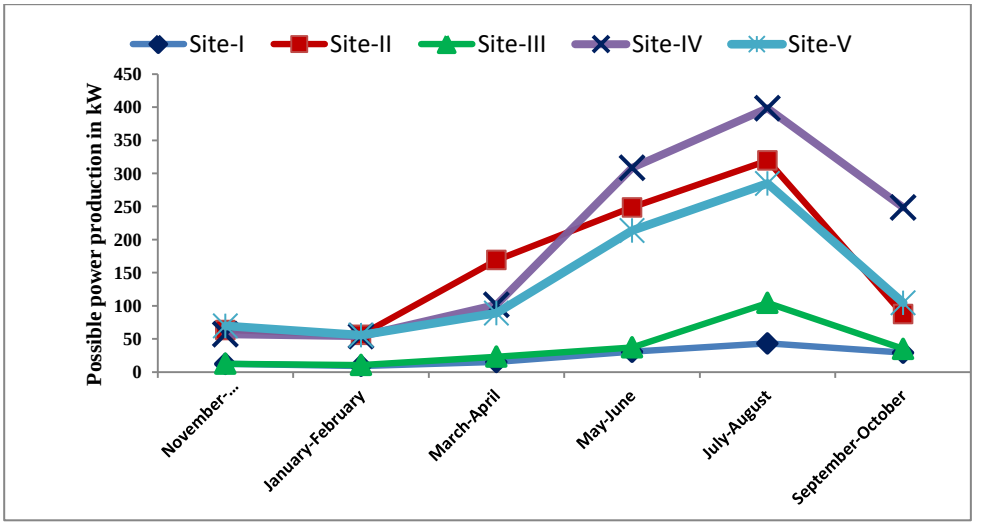


Figure 6: Possibility of power production in five sites (individually) per two months

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

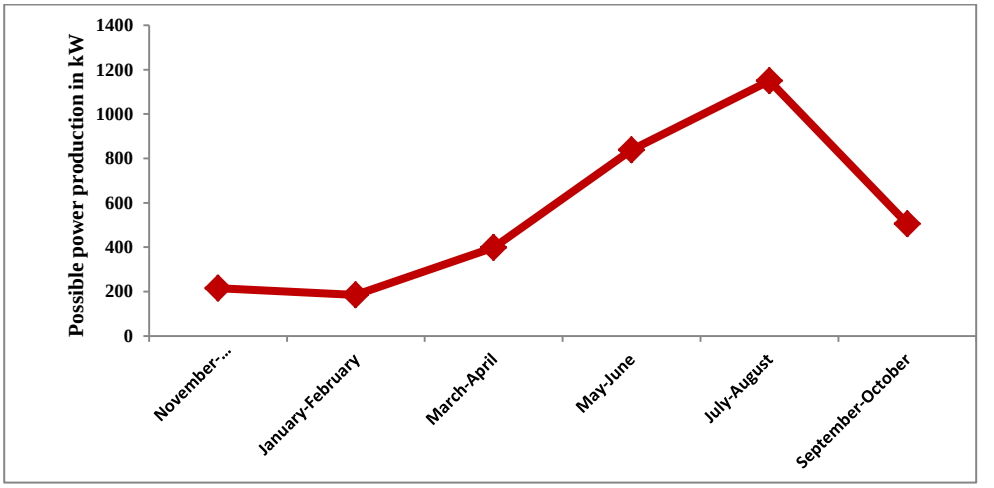


Figure 7: Sum of the possibility of power production per two months by all selective sites

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 decreases 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.

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.

Acknowledgments

The author would like to thank Green Energy Foundation of Bangladesh, Late Professor Dr. Nurul Islam, Mahmuda Ferdous, Rajib Debnath, Mizanur Rahman, Pear Hossain, and Abul Hasem for their contributions in this research.

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