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Feasibility of Integrated Pico Hydro System at Choto Komoldoho, Mirsharai

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ABSTRACT
Renewable energy can be an effective option to meet up the electricity demand of people. Where grid connection is not possible, power generation from renewable energy resources can help to meet up the load of these off-grid places. This present study aims to find out the feasibility of Pico hydro scheme on the waterfall of Choto Komoldoho, Mirsharai, Chittagong, Bangladesh. The Pico hydro system was integrated with PV to form a hybrid system. The whole system was simulated by Homer software. It was found from the simulation that the cost of energy is $ 0.270 /kWh which is 21.6 taka in BDT (1US=80 Taka).

Keywords: Pico hydro, Choto Komoldoho, Homer.

1. Introduction

In the era of fast technological development, renewable energy sources have drawn a lot of attention for generating electricity. Different renewable energy sources like wind, biomass, tidal/wave, micro-hydro and PV are used as they are inexhaustible in nature and their capability of delivering clean power. These renewable energy sources are the best alternative for power generation where grid connection is not available and where grid connection cost is high. By combining several locally available renewable sources to form a hybrid system this problem can be solved as it will ensure both the quality and reliability of electricity supply [1-5]. Hydro-power plant is a plant that converts the kinetic energy of the falling water into mechanical energy by the turbine. This turbine then drives an electric generator to produce electrical energy. People started using hydro-power to produce mechanical work for mainly agriculture purposes thousands of years ago. In 1882, the first hydro-power plant was built to produce electric energy. It was considered the first technology used to produce electricity from a renewable source [6]. Now almost 20% of worldwide needs are fulfilled by hydropower plant [7]. Hydro-power plants can be classified according to size or capacity as shown below [6] in table 1.

Table 1: Hydro system classification

Hydropower plant	Capacity
Pico Hydro	< 0.005 MW
Micro Hydro	< 0.1 MW
Mini Hydro	< 1 MW
Small Hydro	between 1-100 MW
Medium Hydro	>100 MW
Large Hydro	>500 MW

Being a developing country Bangladesh faces difficulty in ensuring reliable power to everywhere in the country. Due to the lack of availability of transmission and distribution network infrastructure and lack of adequate generation, about 45% of the population remains off-grid and grid connected places face acute load shedding [8]. For developing their sustainable energy, Bangladesh government has adopted many renewable schemes . At present natural gas contributes to 80% of total electricity generation in Bangladesh [8]. Most of the power plant in Bangladesh operates on natural gas, few on oil and coal. But due to the shortage of gas, several units of power plants have stopped working in Chittagong, the port city of Bangladesh [9]. Kaptai Hydropower plant is the only renewable energy source which is connected to the grid. It accounts for around 2.58% of total electricity generation [8].To improve the condition Bangladesh government has adopted Renewable Energy Policy. It obligates that 5%of total electricity production will be achieved by 2015 and 10% by 2020 [8].

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2. OBJECTIVES OF THIS RESEARCH

The objective of this research is to find out the feasibility of Pico hydro scheme at Choto Komoldoho, Chittagong, Bangladesh. First, the available head and then the available flow rate were measured to estimate the power generation capability from this site. Then Homer software was used to simulate the proposed hybrid system in order to find out per unit cost of the simulated system.

3. Data collection

Choto Komoldoho, Mirsharai, Bangladesh.

A. Survey on Choto Komoldoho waterfall

Choto Komoldoho is an unfamiliar trail. Several streams can be found on this trail. It is located between Dhaka Chittagong highways, Mirsharai. The survey was conducted in January 2018.

Distance: 1.5 hours of bus journey from Chittagong town.

Availability of Water: All seasons.

Measuring flow for Choto Komoldoho waterfall:

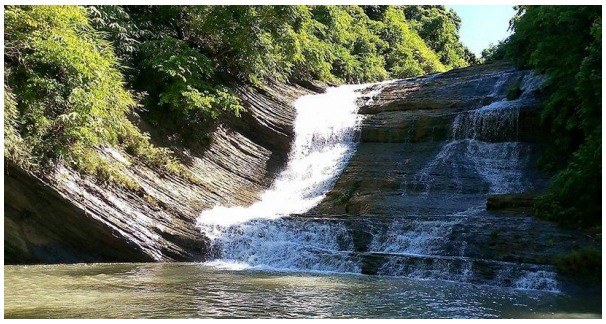

Figure 1: Choto komoldoho

To measure the flow rate bucket method was used. For this, a bucket of 10 liters (2.65gallon) was used. To measure the time taken to fill up the whole bucket, stopwatch was used.

Table 2: Flow rate measurement

No of observation	Time (s)
01	5.05
02	5.02
03	6.02
04	5.20
05	5.10
06	5.20
07	6.30
08	6.00
09	6.10
10	5.4

Average time, t= 5.5 s

Flow rate, Q=28.90 gal/min

= 2.2 lit/s

=.0022 m3/s

The flow rate was found after dividing the volume of the bucket by average time.

Actual Flow: 0.83*0.022 =.001826m3/s. (A correction factor 0.83 should be used as the velocity of upper and lower surface of the stream is not equal due to the wind and other natural impacts)

Head, H = 140 feet = 42.67m

Considering 8% losses of the available head the net head becomes 39.26 m.

Theoretical Power:

For 50% overall efficiency,

The Power, **P** = efficiency (%) * flow rate * head (m) * Gravitational acceleration * Density of water

= 0.5 * 0.001826 * 39.26 * 9.81 * 1000 = 0.35 KW

4. Simulation

By renewable software 'Homer' [10], per unit cost analysis can be evaluated of a hybrid system.

A process to design integrated Hydropower plant in 'Homer':

A. Components Selection:

For designing this model first 'Add/Remove' button 'Hydro and primary load, PV, Hydro and Converter, Battery'' is selected (figure 2).

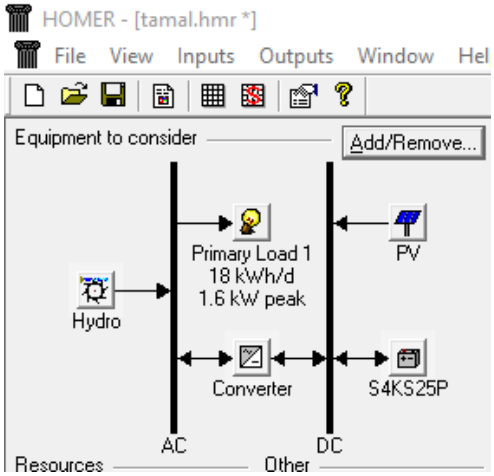

Figure 2: Optimum Model

B. Renewable Resources Input

Solar Resource Data input

Twelve months of solar radiation data for 'Mirsharai was collected' using 'Homer' Software via the internet (figure 3).

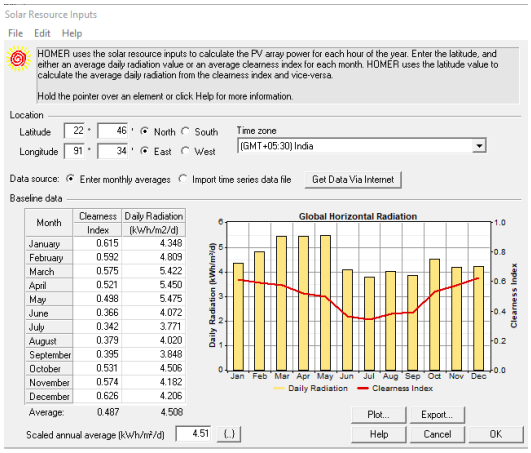

Figure3: Daily radiation data of Mirsharai.

Hydro Resource Data Input:

The survey was conducted in January 2018. Rainy season in Bangladesh starts from the middle of June and ends to the middle of August. Based on the summer and rainy season of the country, hydro data have been inputted (figure 4).

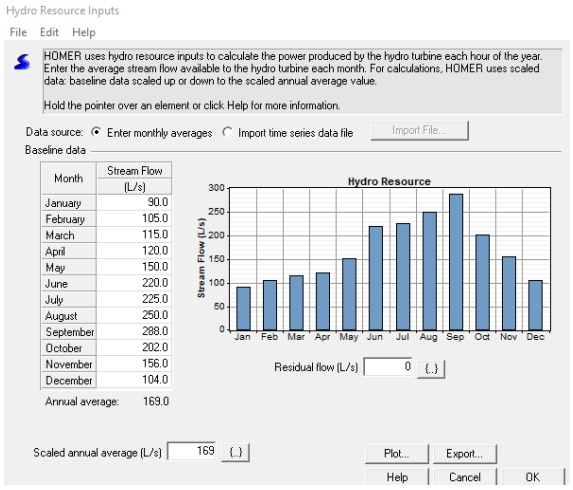

Figure 4: Hydro Resource data

C. Cost and Size Parameters Input in 'Homer

For this renewable project, the standard capital cost has been inputted in Homer.

Table 3: Capital cost of various components in Homer

Input Parameters	Values
7 KW PV	2520 $/year
Battery Capital Cost	3150 $/year
Converter Capital Cost	158 $/year
0.359 KW Pico Hydro Capital Cost	1500 $/year

For this renewable project operation and maintenance cost with replacement cost has also been inputted in Homer.

Table 4: Operation and maintenance cost with replacement cost of various components in Homer

Input Parameters	Values
Hydro Operation & Maintenance Cost	100 $/year
Hydro System replacement Cost	400 $/year
Solar System replacement Cost	2520 $/year
Solar Operation & Maintenance Cost	70 $/year
Battery Operation & Maintenance Cost	70 $/year
Battery replacement Cost	2450 $/year
Converter Operation & Maintenance Cost	10 $/year
Converter replacement Cost	158 $/year

D. Per unit Cost Simulation

To find the optimum sizes various sizes have been considered in this simulation of Homer. After simulation, it was found that the optimum size for PV is 7KW, 7 batteries, 2 KW converter is required**.** From simulation result, it was found that COE is $0.270/KW which is 21.6 taka in BDT (1US=80 Taka).

Figure 5 depicts per unit cost of the proposed hybrid system.

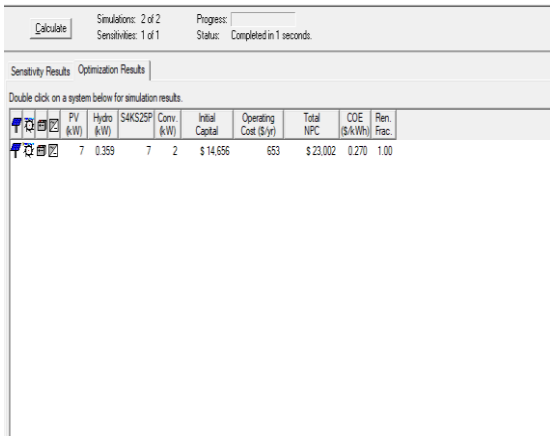

Figure 5: Per unit cost result.

5. Conclusion

In this paper, a hybrid system was designed to meet up the load for Choto Komoldoho, Mirsharai. The system comprised of PV array, Pico hydro scheme, converter and battery. It was found that the system meets the demand when the cost of energy is $0.270/KW. It was

also found that the optimum size of PV panel was 7 KW. The government should emphasize more renewable energy projects like Pico hydro to reduce pressure on fossil fuel. Being a renewable form of energy it will reduce environmental pollution.

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