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Perspective and Challenge of Tidal Power in Bangladesh

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***Abstract*—**Tidal power can play a vital role in integrating as new source of renewable energy to the off-grid power connection in isolated areas, namely Sandwip, in Bangladesh. It can reduce the present energy crisis and improve the social, environmental and economic perspective of Bangladesh. Tidal energy is becoming popular around the world due to its own facilities. The development of any country largely depends on energy sector improvement. Lack of energy sector is because of hampering progress of any country development, and the energy sector will be stable by only depend on sustainable energy sources. Renewable energy having environmental friendly is the only sustainable solution of secure energy system. Bangladesh has a huge potential of tidal power at different locations, but effective measures on this issue have not been considered sincerely. This paper summarizes the current energy scenario, and Bangladesh can produce power approximately 53.19 MW across the country to reduce the growing energy demand utilizing tidal energy as well as it is shown that Sandwip is highly potential place to produce tidal power, which is estimated approximately 16.49 MW by investing only US $10.37 million. Besides this, cost management for tidal power plant has been also discussed.

***Keywords*—**Sustainable energy, tidal power, cost analysis, power demand, gas crisis.

I. Introduction

RENEWABLE energy provides secure energy for any country to develop its infrastructural, socio-economic, agricultural, educational, health and community sector in stable condition. Renewable energy means sustainable energy which is environment friendly, cost effective, non-polluting and future predicted energy sources. That is why developed countries are shifting their energy sector toward sustainable energy to maintenance their continuous growth. Tidal is one of the sustainable energy sources and have huge potential to produce power from its energy [1]. Many countries are taking advantage from tidal energy to produce power for successfully transferring the energy sector into sustainable energy. Bangladesh has also opportunity; Sandwip is one of them, to use its facilities in various locations observing in proper way and guidance. It is mandatory to develop the energy sector before developing a country, in this regard tidal energy in Sandwip can play a vital role to improve its locality with integrating development of country [2]. Sandwip project will be slightly helpful to mitigate the present energy crisis and shifting energy sector toward sustainable energy sources. This paper is mainly divided into four parts 1. Energy sector condition and shifting 2. Tidal power 3. Feasibility study of Sandwip, and 4. Data analysis.

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II. Energy Sector Condition and Shifting

Bangladesh, only 46% people are in grid connected [3], is one of the lowest electricity consumptive country regionally and globally [4]. The existing power system cannot produce sufficient power for the whole nation. Scarcity of power is a principal infrastructural handicap in the development and growth of any country [5]. The growth of the energy sector in Bangladesh is not sufficient to meet the power demand, which is increasing by 10% annually [6]. Electricity supply in the rural and remote areas has been restricted due to transmission losses, high transmission costs, distribution costs, and greatly subsidized prices. Growing population and financial activities drive the country toward high electricity demand. The shortage of electricity was 1452 MW to meet the high demand in 2012, though the maximum electricity generation was 6,066 MW. According to [7], in 2010, the shortage of gas supply hinders the electricity generation around 500-800 MW.

A. Gas Dependent Power Generation

At present, power plant generates power utilizing 76.14% of our gas reserve [8], which is 37% of total gas, but consumption of gas demand increase at rate about 8% per year [8]. However, at the present consumption rate of gas reserve leads it up to 2020 year [8], whereas net remaining recoverable gas was 11.48 TCF at the end of 2010.

Fig. 1 shows the percentage of installed generation (8072 MW) capacity in Bangladesh from various sources in 2012.

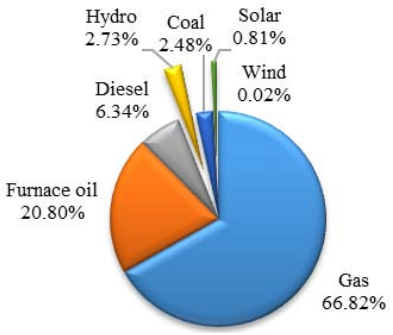

Fig. 1 The percentage of electricity generation in Bangladesh from different sources [6] and [9]

It is seen that from Fig. 1, gas dependent power plant was installed 66.82% of total installed capacity, but in actual case, some of other fuel dependent plants were abandoned, so total

power generation was more depend on gas than the scenario. Sustainable energy sources use only 3.56% of electricity production. Fossil fuel use 96.44% of total generation which is polluting the air, land, and water and emitting CO_2. These pollution and emanation guide to environmental dilapidation which results bigger climate hazard and natural disasters.

B. Power Generation Planning

Power demand is increasing higher and becoming more as years go further, but growing high nature demand is going to be encountered by vulnerable energy source plan [6], though recently need for power is being met by quick-rental power plants which require costly liquid fuels. To meet the next power demand, Power Development of Bangladesh proposed roadmap for 2030 "The Power System Master Plan (2010)" recommending that the 50% of power generation would be coal-based but this planning is not environmentally friendly, security energy planning, rather it helps in the increasing global warming through breathing CO_2. Our total coal reserves are 2,527 million tons according to Bangladesh's National Energy Policy 2004.

C. Towards Sustainable Energy

As fossil fuels are depleting at a higher rate, so we have to think to other sources mainly renewable. The country is going to be facing a severe energy crisis after the fossil fuel finish. So, country has no energy security in this respect. Thus, sustainable energy is the only solution to get rid of this problem; which is becoming more acute as years proceed. To proceed fully toward renewable energy sources require some time, so in between these transaction periods fossil fuel can play a vital role. Toward the moving secured and sustainable energy sources, tidal power can assist to play a role in this regard.

III. Tidal Power

Commercial ocean energy capacity (most tidal power facilities) remained at about 527 MW at year's end, with little added in 2012 [4]. The world's first and second large-scale tidal power plant, the Rance Tidal Power Station located at the estuary of the Rance River, operated in 1966 is 240 Megawatts, which is generated by its 24 turbines. It supplies 0.012% of the total power demand of France [10]. The world's biggest tidal power station operated by the Korean Water Resource Corporation in 2011 having total output capacity 254 MW with mean operating tidal range 5.6 m is situated at Sihwa lake tidal power station. Total cost for this project was 288.6 million dollars met by the South Korean Government [11]. Incheon Tidal Power Station which is under construction, another large tidal power station, is expected 44x30=1320 MW generating capacity at the Incheon Bay in South Korea. Total development and construction cost are hoping to reach US $3.4 billion with completion in June 2017 [12].

A. Bangladesh Perspective

Bangladesh, electricity consumption per capita is only 154 Kwhr which is much less than any developed country [13], has an extended costal area with 2-8 m tidal height ascend and descend [14]. This height is adequate enough to generate power. Tidal energy can be simply generated from the varying sea levels, and tides are more foreseeable than wind and sunlight. Tidal currents can be precisely anticipated within 98% accuracy decades into the future [15]. Changing tidal can be used to produce electricity across a coastal bay with huge differences between low and high tides. Electricity generation from tides is very analogous to hydroelectricity generation apart from that water; which is able to run in both directions, and electricity is produced using two-way turbines. The technology used in tidal power is very simple and has a probable life of more than 40 years [16].

B. Advantage

Production of electricity from tidal is 24 hours a day and 365 days a year and has a highly efficiency (80%) competitive with other power sources. Costal people can irrigate and make their life more solvent economically than before by means of tidal power. A set up expenditure to build a tidal energy plant is high, but the repairing costs are very low. The price of electricity has been paid off in 15 or 20 years after the capital costs and can be assumed to be almost zero. So, profit can be earned using tidal power technology [16].

IV. Feasibility Study of Sandwip

Sandwip, the eastern side of the delta region, is most approving locations for tidal power application. A flood control barrier exists around the entire island, and this contains 28 sluice gates. These barrages and sluice gates can be used for electricity generation. Therefore, the potential of tidal power is very accessible to be applied because the barrages are essential for controlling flow through turbines, which is also essential for controlling flood. This invalidates high capital cost for the engineering is already there or is crucial for cyclone protection.

The energy available from a barrage is dependent on the volume of water. The potential energy contained in a volume of water is [18],

$$E=\frac{1}{2}A\rho gh^2 \quad (1)$$

where,

A = area of basin (m^2)
ρ = water density (kg/m^3)
g = acceleration due to the Earth's gravity, and
h = tidal range (m)

Output Power, P = (Energy (E) x turbine efficiency)/ 86400(W) (2)

Power generation from tidal can be computed using (2).

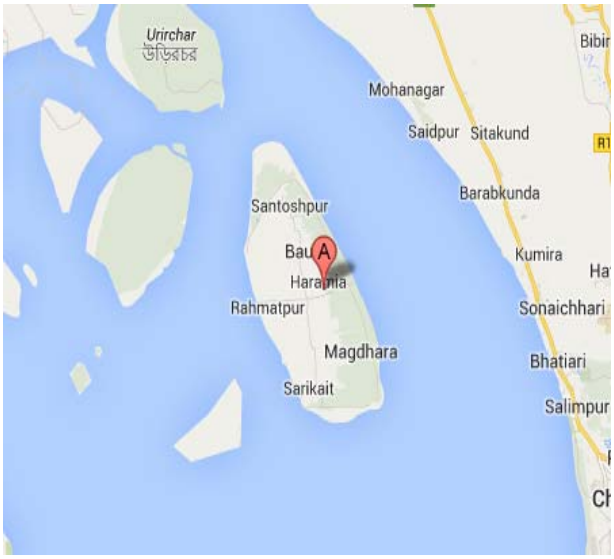

Fig. 2 Sky scenario of Sandwip from Google map [17]

A rough estimate of investment and power production by tidal power in Sandwip are shown below.

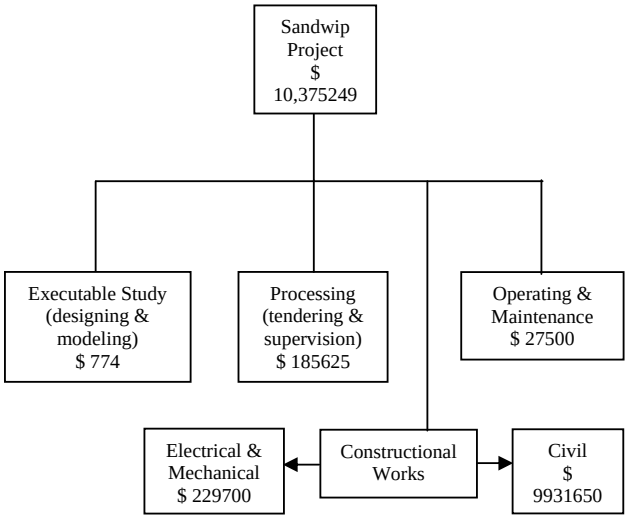

Fig. 3 Flow chart of estimated cost of Sandwip project

A. Cost Management and Estimating

Economic support can be obtained from different sources of financial institutions, those help to develop sustainable energy system such as World Bank Climate Investment, the Adaptation and the Least Developed Countries Funds [19]. Moreover, Clean Development Mechanism and Carbon Finance, internationally recognized mechanisms, give the opportunity to make funds for installing any sustainable project to develop a nation. The main aims of above mentioned organizations are to reduce gas emission and vulnerable situation for the adverse effect of climate change promoting green energy technology and sustainable developing the poorer communities of the developing world [20]-[22].

Since, Bangladesh is a most vulnerable country selected in COP15 conference and developing, which is suffering most for the climate change. So, tidal power project in Sandwip will be positive for this country and getting available financial support from all the above cited organization.

Sandwip project is mainly divided into 4 categories.

- Executable study: Executable study involved in the proper location selection, land rights, environmental judgment, interconnection energy accord, system modeling, preliminary designs (electrical, mechanical and civil) and complete expenditure list. To do this study, approximately US $ 774 need.
- Processing: It includes engaging managers, engineers, and laborers allowing sufficiency food, accommodation, and so on. Besides, from the executable study outcome; different tendering process will be approaching, selecting, evaluating and supervising the whole activities worth is US $ 185625.
- Constructional works: It is mainly divided into two parts

a) Civil works: This includes access roads, basin installation, power house establishment, and location setting.
b) Electrical and mechanical works: These include establishing essential equipment such as protection systems, turbines, generators, transmission lines, communication lines, controlling, monitoring and so forth.

The total cost for these works is US $ 10161350 and finally

- Operation and maintenance: These provide for the total project considering administrative costs like leases, remunerations, fees, etc. The nearly value of operating and maintenance is US $ 27500.

So, total cost need to implement and operate a tidal power base sustainable energy is around US $10.37 million.

TABLE I
SUMMARIZED OF SANDWIP PROJECT

Parameter	Value
Tidal range	4.86 m
No. of Sluice gates	28
No. of turbine uses	05
Basin area	$4x10^6$ m^2
Construction time	4 years
Cost	US $10.37 millions
Output Power	16.49MW

V. DATA ANALYSIS

Sandwip has a great potential to produce power from tidal is around 16.49 MW, which is quite helpful to shrink power crisis through sustainable energy in Bangladesh by investing only US $ 10.37 million. Nonetheless, other parts of the country can produce energy around 53.19 MW from different tidal ranges [23] considering basin area $4x10^6$ m^2 [24], which is shown below.

TABLE II
ESTIMATED POWER GENERATION FROM DIFFERENT LOCATION OF BANGLADESH

Name of the station	Mean tidal range (m)	Output power (MW)
Sandwip	4.86	16.49
Sadarghat (cht)	3.70	9.56
Mongla	3.26	7.40
Char Changa	3.22	7.24
Cox's Bazar	2.70	5.09
Teknaf	2.54	4.51
Hiron Point	2.04	2.90
	Total	53.19

VI. CONCLUSION

With the increasing power demand in Bangladesh, there is no substantial plan to meet the upcoming power crisis by renewable energy. The country has a great challenge in the upcoming days due to unsustainable dependent energy sources. In this respect, tidal power, as a renewable source of energy with numerous profits, can be a prime supplier for our future energy necessities increasing local hydroponic management with Sandwip's socio-economic improvement. In our analysis it is found that Bangladesh has immense potential of renewable energy sources like tidal power; which can add at least 16.49 MW power in Sandwip area giving a solvent economic, social, and psychological improvement in this regional person. Moreover, tidal power can generate total 53.19 MW from different places of the country, but still now no effective effort can be seen to produce power from this source.

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