Perspective and Prospect of Tidal Energy in Bangladesh

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Abstract— Capital of Bangladesh, Dhaka is one of the most polluted city in world. This polluted city is adversely affecting the whole country. Steam, Gas, Coal, Diesel and other fuel based power station is polluting the air, water, land and biological environment day by day. These power stations also making the environment noisily. Moreover the efficiency of these power stations is decreasing day by day. It is because most of the power station in Bangladesh is 50-60 years old. Bangladesh is trying to meet up this crisis by IPP and other different policies. These policies may be a temporary solution but not permanent solution. Another problem is most of the power station is gas based and it is used 88.39% of total generation So now government is looking for alternative energy solution especially renewable energy. Solar and Wind energy are introduced in Bangladesh and currently solar energy is very good in progress. Compared to them other renewable energies are still lag behind, especially tidal power. The potentiality of tidal power in Bangladesh have not yet realized by the authority due to scold environmental concern, lack of interest to invest money and absence of modern technology. Bangladesh has a long costal area with 2-8 m tidal head/height rise and fall. This height is sufficient enough to produce power. So tidal power have a bright future in Bangladesh. The main objective of this paper is to discuss the necessity of tidal power in Bangladesh which may be an effective solution to overcome the recent power crisis in Bangladesh.

Index Terms— Power, alternative energy sources, Renewable Energy, Environment pollution, Costal Area, Modern Technology, Generation, Policies.

1 Introduction

Now a day's tidal power is knocking the future for electricity production. The use of tidal power dates back to about 900 AD when early civilizations constructed tide mills. These mills used the force of the tide to turn a waterwheel, which in turn was used to grind grain into flour [1].Britain and France using the tidal power concept since at least the 11th century for milling grains [2]. The first study of large scale tidal power plants was by the US Federal Power Commission in 1924 which would have been located if built in the northern border area of the US state of Maine and the south eastern border area of the Canadian province of New Brunswick, with various dams, powerhouses and ship locks enclosing the Bay of Fundy and Passamaquoddy Bay .Nothing came of the study and it is unknown whether Canada had been approached about the study by the US Federal Power Commission[3]. The world's first large-scale tidal power plant (the Rance Tidal Power Station) became operational in 1966. The facility is located on the estuary of the Rance River, in Brittany. With a peak rating of 240 Megawatts, generated by its 24 turbines, it supplies 0.012% of the power demand of France [4]. The second tidal barrage was put in service at Annapolis Royale.Nova scotia, Canada in 1982 in order to demonstrate the functioning STRAFLO turbine, invented by Escher-Wyss of Switzerland and manufactured by GE in Canada. This 16 MW turbine has some difficulties with clogging seals necessitating two forced outages, but has been functioning without interruption since its early days. There are approximately 10 small barrages scattered throughout the world, but they are intended for commercial power generation. For example there is a 200KW tidal barrage on the river Tawe in Swansea Bay. China has several tidal barrages of 400KW and less in size [5]. Bangladesh has a long coastal zone, most of which is covered by embankments and sluice gates (Yunus, 1998; ESCAP, 1992; D'Ercole and Pigeon, 1998). In most cases, the coastal area of Bangladesh is remote from population centers and has no electricity (ESCAP, 1992 & 1998). But this coastal environment is very resourcefull in terms of agricultural production, shrimp aquaculture, and other business and commercial activities (Underwood and Chapman, 1999; Calderon and Alvarez-Villamil, 2000). Presently this area has expanded shrimp aquaculture haphazardly, which is unsustainable (Salequzzaman, 2001). This expansion has not been integrated with electricity supply (Bhatta and Bhat, 1998; Hotta and Dutton, 1995) Some recent studies have suggested that coastal Bangladesh is ideal for harnessing tidal electricity from the existing embankments and sluice gates by utilizing smallscale appropriate tidal energy technology (Salequzzaman et.al., 2000; Corry and Newman, 2000). Lack of electricity is the main barrier to coastal development in Bangladesh (Saleemul, 1998).So Bangladesh can take tidal power generation as a challenge and can easily overcome at least some of the power crisis.

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2 Advantages of Tidal Power

2.1 Economic

Most of the people leaving in costal are meting up their regular financial crisis by fishing, boating and so on .But these are not permanent solution for them. But by using tidal power they can irrigate and can make their life economically more solvent then before. A startup cost to build a tidal energy plant is high, but the maintenance costs are very low. The cost of electricity after the capital costs have been paid off in 15 or 20 years can be assumed to be nearly zero. So profit can be earned. One of the economic benefit of tidal power is it can result in extremely low costs per Kw.hr once it is built.

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2.2 Technical

The 1st advantage of tidal energy is found in the high energy density of ocean currents. Sea water is 832 times as dense as air, providing an 8 knot ocean current with the equivalent kinetic energy of a 390km/h wind [6]. The 2nd advantage of the turbine of tidal energy design is allowing the turbine to optimally capture the kinetic energy of the flowing water. Tapping this power, can satisfy electricity demands in the multiple-gigawatt range by linking "Ocean Class" Hydro Turbines (7-14MW each) in series across an ocean passage. Smaller energy loads can be met by deploying the "Mid-Range" 250kW power system in off-grid communities, remote industrial sites and regions with established net metering policies. The 3rd advantage is the operation of tidal power plant is intermittent with load factor 22-35%.Plant lifetime can be bery long. For the barrage structure the lifetime is 120 years and for the equipments it is 40 years. The 4th advantage is the shut down capacity. Nuclear power plants cannot be shut down quickly and are operated 24 hours per day and, therefore, nuclear power is a base-load type of power. Fossil fuels are somewhat easier to shutdown but typically they vent the steam to the atmosphere when demand for electricity declines at night. But tidal power is a power source that can be shut down quickly and restored quickly without major losses in efficiency. The 5th advantage is tidal power plant produce electricity 24 hours a day and 365 days a year and the output of the tidal power varies square of the tidal range. For example a tidal range of x gives a power output of y, then a tidal range of 50x will give a power output of 2500y.An additional advantage for the tidal Energy power system is common to other ocean energy extraction technologies, PV systems and wind power generations, namely, that the technology does not rely on fuel to produce electricity nor does it emit greenhouse gases [6].

2.3 Renewability

In an energy-hungry world people is seeking for energy to meet up for the future crisis. But oil, gas, coal and other recourses will be finished within 40 years. So renewable energy is the only solution for meet up the future crisis. Solar, wind, wave, tidal, fuel cell, geothermal etc are the renewable energy sources. Tidal power/energy is more predictable than solar or wind and other energies. Rise and fall of tides is more cyclic than random weather patterns.

2.4 Security

Tidal barrages or small dam can secure a city. It can protect the city from dangerous tide during storm.

2.5 Efficiency

Tidal power is highly efficient. Its efficiency is about 80%.It means Tidal turbines are up to 80% efficient in converting tidal energy to usable electricity. It is also said that bigger the power generating equipment, the higher the efficiency. As because tidal generators not use fuel they are more efficient and long lusting (30-50years) compared to other generators. The efficiency of tidal power is much higher than solar or wind energy generators.

3 Some Disadvantages of Tidal Power

Besides some advantages there are always some disadvantages. Tidal powers also have some disadvantages. They are-

According to the AES (Alterative Energy Source) there is considerable effect on the ecosystem. The exchange of water volume between a basin and the sea is reduced; this leads to the potential for increased pollution, because pollution is left accumulating in the basin. Also, because the exchange of volume is reduced, salinity of the basin decreases and sediment accumulation increases. Basically, anything we place in the water can and does affect the ecosystem.

A barrage across an estuary is very expensive to build, and affects a very wide area - the environment is changed for many miles upstream and downstream. Many birds rely on tide uncovering the mud flats so that they can feed. Fish can't migrate, unless "fish ladders" are installed. But the negative impacts on migratory fish of tidal power generation can be mitigated easily. According to Turnpenny's (2001)[8] experience as former head of the Aquatic Technology research section of the Central Electricity Research Laboratories (subsequently of National Power) in the UK Tidal Power program of the 1980s and clearly 1990s and subsequent research applied to freshwater hydropower generation: "Fish injury mechanisms in turbines has advanced since the 1980s-early 1990s and there are now much better prospects of quantifying possible damage to fisheries and, more importantly, designing and operating turbines to be more 'fish-friendly'" .

Water is not replenished, it can flow away. So any dirt or pollution lingers around the cost much longer. Silt builts up behind the barrage.

Power produces only 10 hours a day.

Initial building cost is very expensive.

There are only few sites suitable for tidal barrages.

Tidal Barrages may affect the tidal level - the change in tidal level may affect navigation, recreation, causes flooding of the shoreline and affect local marine life.

Causes a continual loss of mechanical energy in the Earth-Moon system (Due to pumping of water through the natural restrictions around coastlines and viscous dissipation at the seabed and in turbulence.

Loss of energy has caused the rotation of the Earth to slow in the 4.5 billion years since formation losing 17% of its rotational energy.

May take additional energy from the system, increasing the rate of slowing over the next millions of years.

TABLE 1
COMPARATIVE STUDY OF THE USE OF RENEWABLE ENERGY [5]

Evaluation	Solarthermal	PV	Hydro	Wind	OTEC	Tidal	GEO
Capital cost	Large	Large	Enormous	Moderate	Enormous	Enormous	Small
Operating Cost	Moderate	Modarate	Negligible	Small	Unknown	Negligible	Small
Efficiency	15%	5-10%	80%	42%	7%+	25%	100%
Renewable	Yes	Yes	Yes	Erratic	Yes	Yes	No
Storage	Not needed	Unclear	Built-IN	Essential	Not Needed	Unclear	Not needed
Pollution	Non really	Waste Heat	None	Visual	None	None	Steam plumes
Levelized Cost	25cent KWhr 25 cent/ Kwhr.53	16cents KWhr	4 cent KWhr	4.5 cent KWhr	Unknown	Unknown	Low
Enviromental Impact	Modarate	Large	Enormous	Small	Unknown	Unknown	Small
Large Scale	Too eee xpensive	Expensive	Proven	Proven	Unknown	Possible	Possible
Small Scale	No	Difficult	Possible	Definitely	No	Possible	No
Unit Capacity	1000 MW	Depends Acreage	2000-6000 MW	Highly Variable	As large as wise	250MW	1000MW

4 AN OVERVIEW OF TIDAL POWER IN COSTAL AREA (SANDWIP)

Bangladesh has a long coastal area (710 km) with 2~8 m tidal height/head rise and fall [8]. It also has some large tidal sites and many channels of low tidal range in a large number of deltaic islands, where barrages and sluice gates already exist. Therefore, the potential for tidal power to be harnessed is significant, because the barrages necessary for creating controlled flow through turbines (to tap tidal power) are also needed for flood control. This avoids the problem of high capital cost as the engineering is either already there or is needed for cyclone protection. Analysis of the following table [7] indicates that Bangladesh has very good prospects for tidal energy, particularly in Sandwip. The island of Sandwip is located in the Bay of Bengal, adjacent to Chittagong and is a mere 15 km from the mainland. The entire island is 50 kilometers long and 5-15 kilometers wide The population is around 472179(as of 2009) on an area of 357 km2. The entire island is a mudflat created from the Ganges delta. The 5 m tides experienced at Sandwip results in poor accessibility, with the island constantly surrounded by mud flats, except during high tides. The island is subject to flooding from cyclones and in 1991 over one thousand people were drowned. A flood control barrage exists around the entire island and contains 28 sluice gates. A short electricity grid is also available linking the main commercial areas on the island. Two diesel generators of 200 KW run for a few hours late afternoon/early evening supplying electricity, mainly for commercial use. Some households have batteries and some diesel generators are used for powering rice threshers. A photo voltaic (PV) system is used to maintain a refrigerator for vaccines in the health centre. 100 kWp solar power generation plant in Sandwip island is largest in Bangladesh. Purobi Green Energy Limited started operation on September 29, 2010. The mud flats are composed of extremely rich soil; hence it is easy to grow a variety of food crops. The island is an exporter of rice and is largely self sufficient in vegetables and fruits. No aquaculture is conducted on the island, though shrimps are collected from the mud flats. None of the island's schools or colleges has electricity and opportunities for employment growth on the island are limited. According to the scoping visit and expert analysis of different tidal range, Bangladesh may harness energy from coastal tidal resources by applying two technologies:

1. Low head tidal movements (2~5 m head); and
2. Medium head tidal movements (> 5 m head).

Therefore, the infrastructure needed for barrages and sluice gates has already been present in this region. These barrages and sluice gates may be used for electricity generation by applying simple technology that can have widespread application. Therefore the potential for tidal power to be applied is significant, because the barrages necessary for creating controlled flow through turbines (to tap tidal power) are also needed for flood control. This therefore avoids the problem of high capital cost as the engineering is either already there or is needed for cyclone protection. In this application, three elements are needed: firstly, the use of an undershot paddlewheel with simple civil construction enabling the placement of the wheel at appropriate locations in the levees/barrages. The existing technology of undershot paddlewheels is historical, and generally uses a greater head as the energy source.

Paddlewheels are generally not as efficient at harnessing the energy from moving water as are turbines or revolving blades using the lift principle; however the proposed application is seen as appropriate. The second element is the use of recently developed, variable speed, electricity generation equipment. This is attached either directly to the wheel or via a simple gearing-up mechanism. The third element is the use of existing electronic controllers, appropriate for small-scale machines, to regulate the power output from variable water flow. The kind of engineering required to adapt the country to increasing sea levels (due to greenhouse warming) can under this scenario be adapted for use as a renewable technology for the future. The environmental issues in the area need to be assessed but the coast is already heavily engineered for control of flooding and also fish farming and rice cultivation. It is hoped that the expected tidal energy projects will provide an integrated approach to coastal development where the tidal power outcome is part of a bigger concept involving aquaculture and water management. This irony is a powerful motivation for tidal power as it reaches to the heart of a future for sustainable development in coastal Bangladesh. There is a lot of potentialities to set up industries and other income generating activities in the coastal region through supplying electricity, which is completely absent at this moment. Shrimp farming in the coastal area of Bangladesh has expanded extensively with the demand of an international market and would be further developed. Besides development of electricity, it will also ensure tourism opportunities, prevent green house gas emissions, ensure the clean development mechanisms, and develop an integrated plan for coastal zone management such as integration of modern aquaculture, livestock, water resource and agriculture management with community development. This technology has the greatest potential of all the renewable technologies for short to medium term application in Bangladesh.

4 CONCLUSION

Tides play a very important role in the formation of global climate as well as the ecosystems for ocean habitants. At the same time, tides are a substantial potential source of clean renewable energy for future human generations. Tidal Energy has the potential and prospect to find a place in the power industry. With its attractive and lucrative features it may pose a competition for the conventional technologies. But with the conventional power plant technology being well established and continued to be in the main Stream Tidal power plants are yet to gain commercial acceptance .Depletion of primary power sources will inevitably force people to replace most of the traditional energy sources with renewable energy in the future. Tidal energy is one of the best candidates for this approaching revolution. For Bangladesh more detailed studies are needed to be carried out. Development of new, efficient, low-cost and environmentally friendly hydraulic energy converters suited to free-Sow waters, such as triple-helix turbines, can make tidal energy available worldwide. This type of machine, moreover, can be used not only for multi-megawatt tidal power farms but also for mini-power stations with turbines generating a few kilowatts. Such power stations can provide clean energy to small communities or even individual households located near continental shorelines, straits or on remote lands with strong tidal currents.

TABLE 2
TIDAL LEVELS IN COASTAL BANGLADESH (BIWTA, 2011) [7]

STATION	LAT	MLWS	MLWN	**ML**	MHWN	MHWS	HAT
Hiron point	-0.256	0.225	0.905	**1.700**	2.495	3.175	3.656
Sundarikota	-0.553	0.036	0.636	**1.829**	3.022	3.694	4.211
Mongla	-0.261	0.325	1.194	**2.310**	3.427	4.296	4.882
Khal No 10	-0.444	0.261	1.231	**2.664**	4.097	5.067	5.772
Sadarghat	-0.423	0.239	1.100	**2.481**	3.861	4.722	5.385
Cox's Bazar	-0.339	0.205	1.023	**1.995**	2.967	3.785	4.329
Shahpuri Island	-0.348	0.191	1.045	**1.874**	2.703	3.557	4.096
Sandwip	-0.583	0.238	1.634	**3.243**	4.851	6.248	7.070
Char Changa	-0.375	0.256	1.060	**2.037**	3.014	3.818	4.449
Khepupara	-0.323	0.195	1.025	**2.060**	3.096	3.925	4.445
Char Ramdaspur	-0.261	0.189	0.763	**2.0361**	3.309	3.883	4.333
Barisal	+0.134	0.434	0.692	**1.539**	2.386	2.664	2.944
Chandpur	+0.019	0.256	0.493	**2.172**	3.852	4.088	4.326
Nalmuri	+0.078	0.370	0.722	**2.195**	3.669	4.031	4.313
Narayanganj	+0.458	0.585	0.697	**2.770**	4.844	4.956	5.083
Galachipa	-0.159	0.283	0.937	**1.764**	2.592	3.245	3.689
Patuakhali	-0.143	0.242	0.740	**1.575**	2.409	2.907	3.293

MLWS = Mean Low Water Spring, MHWS = Mean High Water Spring, MHWN = Mean High Water Neap, MLWN = Mean Low Water Neap, ML = Mean Level, AT = Astronomical Tide, LAT = Lowest Astronomical Tide, HAT = Highest Astronomical Tide, TR = Difference between lowest and highest tidal height in "m".

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