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Tidal Power: An Option for Alternative Sustainable Power Generation in Bangladesh

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***Abstract*-** 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 in order to meet up the future crisis. Solar, wind, wave, tidal, fuel cell, geothermal etc are the renewable energy sources. Among them tidal energy is an old but efficient method. If there is one thing we can safely predict and be sure of on this planet, it is the coming and going of the tide. This gives this form of renewable energy a distinct advantage over other sources that are not as predictable and reliable, such as wind or solar. Rise and fall of tides is more cyclic than random weather patterns. Using this free source we can produce a large amount of power which is very reliable and continuous. The main objective of this paper is show that tidal power may be an alternative solution to meet up recent power crisis.

***Index Terms*-** Tidal power, Fuel, One way tidal power generation, two way tidal power generations, Power crisis.

I. INTRODUCTION

Now a day's tidal power is knocking the future for electricity production. The use of tidal power originated in around 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, 2]. Britain and France are using the tidal power concept since 11th century for milling grains [3,4]. The first study of large scale tidal power plants was initiated 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. The world's first large-scale tidal power plant (the Rance Tidal Power Station) became operational in 1966 [5, 6]. 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 [7]. 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 not 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 [8]. Bangladesh has a long coastal zone, most of which is covered by embankments and sluice gates [9-11]. In most cases, the coastal area of Bangladesh is remote from population centers and has no electricity [10, 12]. But this coastal environment is very resourceful in terms of agricultural production, shrimp aquaculture and other business and commercial activities [13, 14]. At present this area has expanded shrimp aquaculture haphazardly, which is unsustainable [15]. This expansion has not been integrated with electricity supply [16,17] Some recent studies have suggested that coastal area of Bangladesh is ideal for harnessing tidal electricity from the existing embankments and sluice gates by utilizing small scale tidal energy technology [18, 19]. Lack of electricity is the main barrier to coastal development in Bangladesh [20]. Bangladesh can take tidal power generation opportunity as a challenge and can easily overcome at least some portion of the national power crisis.

II. FUEL CRISIS FOR ELECTRICITY GENERATION

Power crisis in Bangladesh is increasing day by day. The generated electricity is far less than the actual demand in our country. Fuel crisis or lack of fuel management is making the current situation worse. In order to generate electricity Bangladesh largely depends on one or two kinds of fuel. As a result, it is getting difficult to supply the amount of fuel needed for power generation. According to government planning, supply and demand of fuel should be adjusted by the end of 2012.But no action is yet taken to fulfill this plan. Power sector is seriously affected by this. Brief explanations of different types of fuel on current situation are given below:-

A. Oil

In our country 30% of liquid fuel is imported to meet up the need of commercial fuel. According to experts, this dependency on fuel is very dangerous for Bangladesh. In last 3-4 year many rental, quick rental and picking power plant based on oil has been established. This has made the situation worse, because the supply of oil is not always possible. Moreover, price of oil have increased. As a result, most of the oil based power plants are need to keep shut down.

B. Gas

The main fuel for electricity generation in our country is Natural Gas. But the production of Natural Gas is not meeting demand for power generation. As of year 2012 70%-80% power plants are run by natural gas in our country. According to Petrobangla, recently government has improved the gas production by 350 million Cubic feet. But the problem is demand have increased by 500 million cubic feet. Because, for special purpose gas connection is provided such as CNG station, but normally gas connection is not provided to anyone. Also, government has taken decision to provide gas connection to industries gradually.

No large gas field is discovered after the discovery of Bibiana gas field at 1996. Foreign companies along with national company Buppex are trying to increase gas production as well as searching for new gas field under PSC act. But this not possible to add up to national grid before 2015.In order to increase gas production recently government is trying to make a contact with Russia's national company Gasprom. According to the contact, 10 new cavities were supposed to be dug. But the contract is not done yet. This 26th April, 2012 delegates of Gasprom supposed to come in Bangladesh. Even if the contact is done this time, it won't help the fuel condition in near future.

C. LNG

In order to improve the gas crisis government has taken new step by importing Liquid Natural Gas (LNG). The amount of LNG imported is equivalent to 500 million cubic feet of natural gas. This will be distributed in Chittagong division. For this Maheskhali terminal was supposed to be build within June-July of the year 2012. But it won't start within this year.

D. LPG

In last few years, LPG (Liquid Petroleum Gas) has become the new source of fuel. But its supply is about one-fourth of demand. There is plan of making adjustment between the supply and demand of LPG. In last June, 2011 finance minister has provided a plan about it. But yet no step is taken about it.

D. Coal

Bangladesh has a good amount of reserved coal; which is a good source of fuel. But our government doesn't have any plan of using this coal but to keep it for future generation. Currently coal is being imported to meet up the demand. Government is planning to import a large amount of coal. But our country does not have necessary infrastructure to import and use this large amount of coal.

E. Biogas

Biogas is made up of the waste of domestic animals. The use of Biogas is increasing in the rural area. But it's limited to few rural families. Only those who have their own domestic animal are getting the help of government to use biogas. Biogas is still at its earliest period, so its use hasn't been spread out yet.

The above discussion gives us a picture that Bangladesh is mainly dependent on Natural gas and imported oil. But the gas reserve of our country will diminish at a time. And importing oil to run power stations is too costly. Since we don't have any good back up plan the consequence may be severe. Also, we are not able to provide sufficient amount of fuel to meet our demand. Day by Day the demand for electricity will increase. If we don't find a new way to backup our existing system, our generating capacity won't increase. This will have a bad effect on our country's overall development.

III. REASON BEHIND POWER CRISIS

There are no particular reason that why our country is drowned in power crisis. Though, our government claims that in last three year electricity situation has been improved. But as soon as summer comes our everyday life is submerged into darkness as load shedding intensifies even though our industries are shut down for 12 hours a day.

At the start of this government's period electricity situation was far worse than now. In order to come out of this problem, one quick solution was to use Rental power plants. This was temporary and quick and also thought out to be advantageous for the government. But after starting these plants it was evident that this has been a harmful step for the whole power generation system. It will take a long time to come out of this situation. But instead of coming out of this mess, government kept pushing the rental power plants. Government decided what would be the buying price of the current and in what price they will supply oil to the plant. There is a big difference between subscriber's fee and government spending. To run these quick rentals government is giving a large amount of subsidy. It is estimated that government will have to give 40 Billion USD worth of subsidy in this finance year. This subsidy is one-third of total revenue. Government is trying to give some amount of money from coming budget. But this may hamper our economical situation.

According to Bangladesh Power Development Board (BPDB), in the year 1990-91 established generating power was 2398 MW. In 2005-06, it became 5275 MW. In this 15 year our established generating power is increased by 5.8% every year. At the same time production power at the time of pick hour is increased from1672 MW to 3812 MW. That is, the actual producing power is increased by 6.1% every year. But there was no increase in generating power at 2006-07 and 2007-08, though maximum generation was increased by 8%. Even if the generating power is increased, there is no guarantee that the generation will also increase.

If we further analyze BPDB's data we will see that, in 1990-91 to 1995-96 established generating power was increased by 4.4%. Till 2000-01 it was increased to 6.6%.But in next 5 year i.e. till 2005-06 it decreased to 5.7%. At first 38 month of this government's period generating power jumped to 11.4%. Actually most of it increased at year 2010-11, when a huge number of rental power plant was running. Question may arise that this large amount of rental power plants why failed to increase power generation. The reasons behind this are-

- The productivity of old power plants (Government) is decreasing day by day.
- Power plants cannot go in full production due to shortage of fuels.
- Generation of rental power plants is less than what is actually said.

According to BPDB the production of electricity in 30th April 2010 was suppose to be 2055 MW. But in 29th February 2012 the production rate decreased at a rate 41% and now the actual production is 1506 MW. So it is clear that due to the shortage of fuel the production of electricity is decreased.

IV. TIDAL ENERGY

Tidal energy is produced through the use of tidal energy generators. The large underwater turbines are placed in areas with high tidal movements and designed to capture the kinetic motion of the ebbing and surging of ocean tides in order to produce electricity. Tidal power has great potential for future power generation because of the massive size of the oceans and if there is one thing we can safely predict and be sure of on this planet, it is the coming and going of the tide. This is the distinct advantage over other sources that are not as predictable and reliable, such as wind and solar. Tides come and go for the gravitational force of the Moon and Sun and also the rotation of the Earth. The rotational period of the moon is about 4weeks, while the earth takes 24hours for one rotation which occurs a tidal cycle of around 12.5hours. Moreover, once the construction of the barrage is complete, the maintenance & running costs are very small and the life time of the turbines are generally very high for instance, around 30years. The above discussion suggests that tidal energy will be a preferred option over the other choices to meet the sky rocketing demand of electricity. There are two types of generation methodologies that are available to generate power. They are (1) one way generation & (2) two way generation system.

A. One Way Tidal Power Generation System

This section of the paper provides a brief overview of the one way tidal power generation system with the view of graphical representation. In one way tidal power generation system one way turbine is used. In order to generate tidal power both sea water level and the river basin water level is considerable. From Figure-1 it is seen that sea water level is varying approximately sinusoidal. During high tide basin water level will follow sea water level very closely because sluice gates are open. When the sea and basin water levels are equal at point P_1, both sluice gates and turbines are closed. It will be closed until a sufficient head H_1 built up. When the heads built up sluice gates at point Q will be open and the basin water level will fall with duration of T. At point P_1' there is not sufficient head H_1' is present to produce electricity. As a result both turbine and sluice gates will be closed until the two levels are equal. The moment these two levels are equal again then next cycle will start. Hence total power generation duration will be T. The advantage of this kind of plant is only one turbine is required for the plant and the cost of the turbine, operation and maintenance are low. Turbine model required for this kind of plant is also industrially available. However, the disadvantage of this plant is the amount of power produced is less. Apart from its demerits this kind of power plant is widely used.

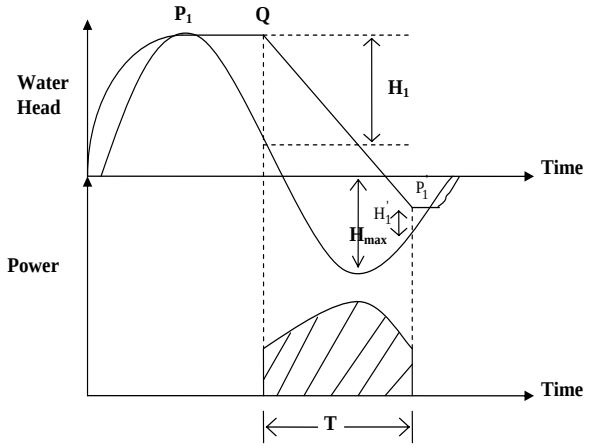

Figure1: One way tidal power generation system.

B. Two Way Tidal Power Generation System

This part of the paper provides a summary of the two way tidal power generation system with the help of graph, indicating the water flow and position of the turbines, basin water level & sluice gates. This section has also enlightened the benefits and hazards of this system and further modification idea for a better output. During high tide water will go through the turbine and therefore there should be a difference between the points L_1 and L_2. Water is passing into the basin from sea eventually basin water level will up. It will be rising until it reaches at point P_2 and a sufficient head build up. At point P_2 sluice gates will be open but turbines are closed until the basin and sea water levels are equal at point M_1. At point M_2 a sufficient head will build up for power generation and then at point M2, turbines will open in opposite direction and basin water level will fall. The dive will last until it reaches at point P_2'. While there is not enough sufficient head to produce electricity (up to H_2'), turbines will be closed but sluice gates are open still at point Q_1. The moment they are equal and will be equal at point Q_1' sluice gates will be closed. After building the next head H_2' sluice gate opens and new cycle begins. From the power output curve it is seen that power duration will be T_1, T_2 and T_3. This obviously illustrates power generation will be higher compared to previous power generation regime. However, the problem is associated with the no load period (NLP). During the no load period the system does not produce any power. This is the foremost problem of two way tidal power Generation system. When no load period occurs there is load shedding for some time. This creates a problem in large tidal power plants. In case for the massive generation using two way tidal power generation system the no load period gets higher. Because of this problem two way tidal power generation

system is normally not preferred and most preferable is one way tidal power generation system. However, two way tidal power generation system has the capability to produce larger amount of electricity which actually attracted the researcher to invent a regime to curtail the portion of no load period and eventually treat this method as a viable option to ensure the energy security.

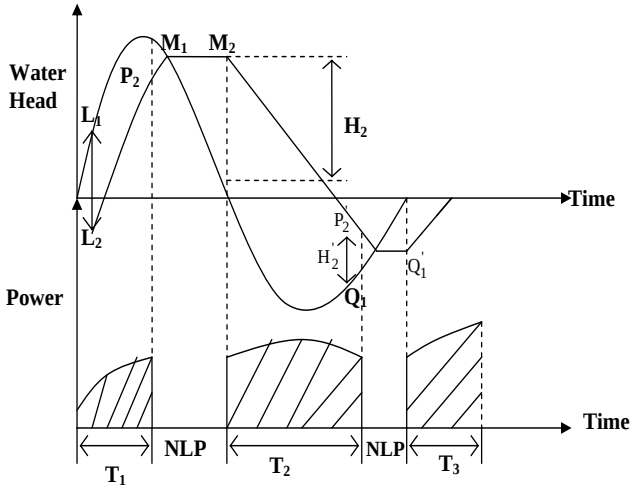

Figure 2: Two way tidal power generation system.

V. TIDAL POWER MAY BE AN ALTERNATIVE SOLUTION

We have discussed about Fossil fuels for power generation. There are also renewable energy sources such as Solar, Wind, Tidal, Hydropower, Nuclear etc. The renewable energy sources are more advantageous than Fossil fuel. They are more environments friendly and cost effective than fossil fuel. Also, fossil fuel will diminish in future. In fact, they have started to extinct. Sun, wind, water are the sources of renewable energy. There is no possibility of extinction of these sources in billion years. Besides, the life time of renewable energy based power stations are longer than fossil fuels. In case of Bangladesh the best form of renewable energy are Hydropower and Tidal Energy. Because Bangladesh is surrounded by a lot river and cannels and this gives practically zero fuel cost. There is long coastline in Bangladesh along the Bay of Bengal. In the coastlines and also in the big rivers of Bangladesh the tidal heights are suitable for power generation. If we compare tidal energy with hydropower and other fossil fuels then we will see that tidal energy is more beneficial than other sources. As it has negligible environmental impact. Also, the maintenance cost is very low compared to others. Though hydropower is renewable source, but it has negative environmental effect on its surroundings. In rainy season hydropower can provide good amount of electricity but in dry season it doesn't have sufficient water to provide electricity. So, it is used as picking power plant. But tide is always constant whether it is in river or sea. So, it can provide constant power all year long. In case of fossil fuels, tidal power's cost per unit energy is significantly lower. Currently, Cost of energy per unit for diesel station is 15.687 Tk, for gas station 18.803 Tk, For Steam turbine (oil faired) is 10.924 Tk, Steam turbine (coal faired) is 2.009 Tk and hydropower is 0.87 Tk.; Whereas according to our research tidal power would be 1.89 Tk .So, cost of tidal power is very low compared to most other power plants. Bangladesh government is not yet able to take benefits from tidal power plant. Day by day the cost of oil, coal will increase. Also, the maintenance costs for fossil fuel based power plants are very high. In case of tidal power maintenance cost is very low since it has only few numbers of turbine and generator. So, we see that tidal energy have a lot of advantages over other forms of fuel sources and very negligible negative impact. Bangladesh has great potential for tidal power in future because of its large number of rivers and also because of the Bay of Bengal.

VI. 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 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. 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. In the near future with its attractive and lucrative features it may pose a competition with the conventional technologies. The conventional energy sources for many countries are almost at their peaks. 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. Moreover, this type of machine 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 islands with strong tidal currents.

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