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A SOLUION TO THE POWER CRISIS USING THE COASTAL ZONE OF BANGLADESH

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Abstract

Bangladesh is a developing country but the power problem is not letting itself to develop fast. No country can develop itself with a lack of power. Bangladesh is blessed by the nature with wind and tidal power. They are used all over in the world in a wide range but in our country it is limited. They are cost efficient because of low maintenance cost. Bangladesh has a long coastal area with a 2-8 m tidal head rise and fall [2]. This height is enough to produce power. The coastal area in the southern part of our country has provided us a huge potential of wind power generation. By the use of the coastal area we can think of a hybrid solution or a minimization of the power problem. This paper is all about hybrid power generation plant.

Keywords**:** Bangladesh, Energy crisis, Wind energy, Tidal energy, Hybrid system.

1. INTRODUCTION

In our country major power stations are run by natural gas and the rate is very high in which the resource is being used. If this alarming rate continues it will a matter of time when the reserve will be fallen. There is no creation of energy; it can only transfer from one to another. Bangladesh is blessed by the nature with the availability of renewable sources and which leads us to them for an alternative solution .The electric load demand of Bangladesh is nearly 6250 MW[7]. Maximum generation is 5787 MW leaving a shortage of 463 MW [7]. With the use of hybrid power generation sources we can solve the problem very much .Wind energy holds a good prospect to this problem. The wind speeds of the coastal regions are considered in this paper. The research on wind energy in Bangladesh is running from 1960 but at then the process of the collection of data was weak compared to now. Tidal energy is the future energy production. In the early past tidal energy were used at tide mills. Britain and France are using this energy for milling grains. But the first large scale tidal power plant was operating in 1966. It was 240 MW rated, generated by 24 turbines [2]. Then Canada constructed a 16 MW tidal power plant. China has many tidal barrages of 400kw or less [2]. Bangladesh has a long coastal area which can be used in different issues. Some recent researches have suggested that the coastal area is ideal for harnessing tidal power. Bangladesh can use the tidal power for electricity generation and can minimize the energy crisis.

2. WIND ENERGY

Wind is the kinetic energy of the moving air. Its power is directly proportional to the velocity. Bangladesh has a coastal length of 724 km along the Bay of Bengal. Winds are available in Bangladesh mainly during monsoon or around of it. Wind speeds are around 3 – 6 m/s which are enough for power generation. This wind blows over our country from March to September. The power increases three times for one time change in the wind speed. For harnessing this power only installation cost is needed. So it is cost efficient over other power stations running. Except for the above mentioned period of four months, a windmill if properly designed and located, can supply enough energy to be marketable.

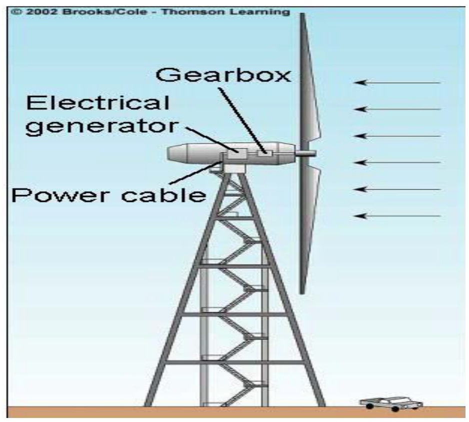


Figure 1: Wind turbine

We cannot convert all the wind energy into electricity. We can convert only 59%, according to “Betz limit” [6]. Although in practical conversion of wind energy to electrical energy is less than that. The output equation for a wind turbine is [6]:

$$P = (\frac{1}{2}) \times \rho \times A \times v^3 (\text{in Watts})$$

Where,
P= power generation;
A= area covered by the rotor;
P= density of wind;
V= velocity of wind;

BPDB is implementing a pilot project of 0.90 MW capacity of the Grid Connected Wind Energy (GCWE) in the Muhuri Dam areas. All the research works in Muhuri indicate that it has a potential of 100 MW wind power capacity [7].

Table 1: Average wind speed in different locations (2003) [1]

Locations	Month						
	Mar	Apr	May	Jun	Jul	Aug	Sep
Teknaf	2.85	2.56	2.39	4.71	2.83	4.14	3.11
Kutubdia	3.78	12.02	2.37	4.71	5.73	4.78	2.92
Sandwip	6.23	8.34	2.28	3.93	5.44	4.44	5.18
Kuakata	3.07	5.26	3.10	3.69	4.28	3.37	2.03
Mongla	3.07	2.41	2.94	4.23	4.34	4.44	2.92

Table 2: Theoretical available power from different locations [1]

Locations	Months	Avg. wind speed (m/s)	Theoretical Available power (W/m^2)
Teknaf	March to Sep.	3.23	20.17
Kutubdia		5.19	83.74
Sandwip		5.12	80.53
Kuakata		3.54	26.68
Mongla		3.48	25.26

3. TIDAL ENERGY

Tidal barrage system is used to harness energy from tides [4]. A tidal barrage is a dam-like structure used to capture the energy from masses of water moving in and out of bay or river due to tidal forces. A tidal barrage first allows water to flow into a bay or river during high tides, and releasing the water back during low tides. This is done by measuring the tidal flow and controlling the sluice gates at key times of the tidal cycle. Turbines are then placed at these sluices to capture the energy as the water flows in and out. A tidal range of at least 7m is required for economical operation and sufficient water head for the turbines [4], [1]. Tides are generated by the rotation of the earth within its ocean envelop as shaped by the gravitational fields of the moon and sun [3]. To an observer at given location on the rotating earth, these causes local sea levels to periodically rise and fall according to highly predictable ,interacting harmonic cycles[4].

The moon's gravitation creates tidal "tractive forces" that create two "bulges" in the earth ocean envelop: one bulges on the side of the earth facing the moon, and the other bulge on the opposite side of the earth [3]. Rotation of the earth between this "bulges" result in two tides per day, or semi-diurnal tides, which is the dominant tidal pattern in most of the world's ocean [3].

The island on Sandwip is 50 km long and 5 -15 km wide [2]. Two diesel run generator is running there along with solar PV model to fulfil the electricity demand [2]. A flood control barrage exists across the entire island and contains 28 sluice gates [2].

The infrastructure needed for barrages and sluice gates are already present in this region [2]. These barrages and sluice gates can be used to generate electricity applying simple technology which can have widespread application. Since the barrages and sluice gates can be used in flood control and generation of electricity here capital cost for tidal power station is minimized which is the first concern for any power stations.

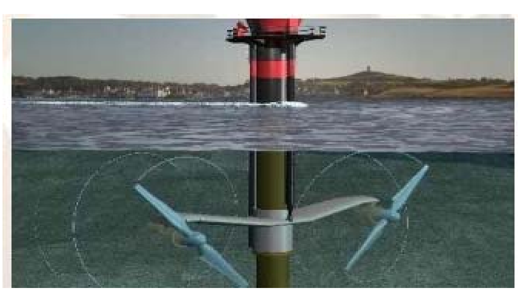
The energy available from a barrage is dependent on the volume of water. The energy contained in a volume of water is [4]:

$$E = \frac{1}{2} A \rho g h^2$$

Where:

- h is the vertical tidal range
- A is the horizontal area of the barrage basin,
- ρ is the density of water = 1025 kg per cubic meter (seawater varies between 1021 and 1030 kg per cubic meter) and
- g is the acceleration due to the Earth's gravity = 9.81 meters per second squared.

The factor half is due to the fact, that as the basin flow empty through the turbines, the hydraulic head over the dam reduces. The maximum head is only available at the moment of low water, assuming the high water level is still present in the basin.



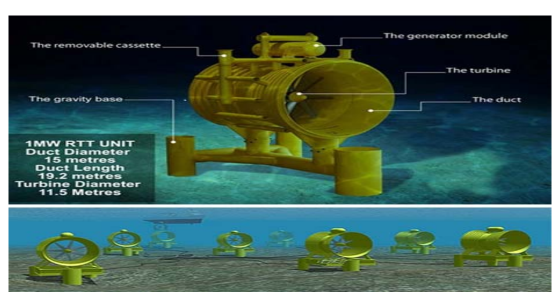


Figure 2: Tidal Stream power plant [5] **Figure 3:** Under water Tidal Barrage power station [4]

For the same speed, tidal power plant is better than wind turbine. The power generated from tidal power plant is 9 times the power from wind turbine.

For a tidal power station [4]:
Say,

- The tidal range of tide at a particular place is 32 feet = 10 m (approx)
- The surface of the tidal energy harnessing plant is 9 km² (3 km × 3 km)= 3000 m × 3000 m = 9×10^6 m^2
- Density of sea water = 1025.18 kg/m^3

The maximum power can be harnessed is 31 MW (approximate). Because the available power varies with the square of the tidal range, a barrage is best placed in a location with very high-amplitude tides.

4. PROPOSED HYBRID SYSTEM :

Our proposed hybrid power system is shown in figure 6. It is consist of wind turbine and tidal power station. The system is designed to give both AC and DC output. DC loads are connected to the load controller where as AC loads are connected via an inverter. AC output is also connected to national grid. A battery bank is connected with the charge controller. We considered the excess generated power will be distributed to the National Grid System.

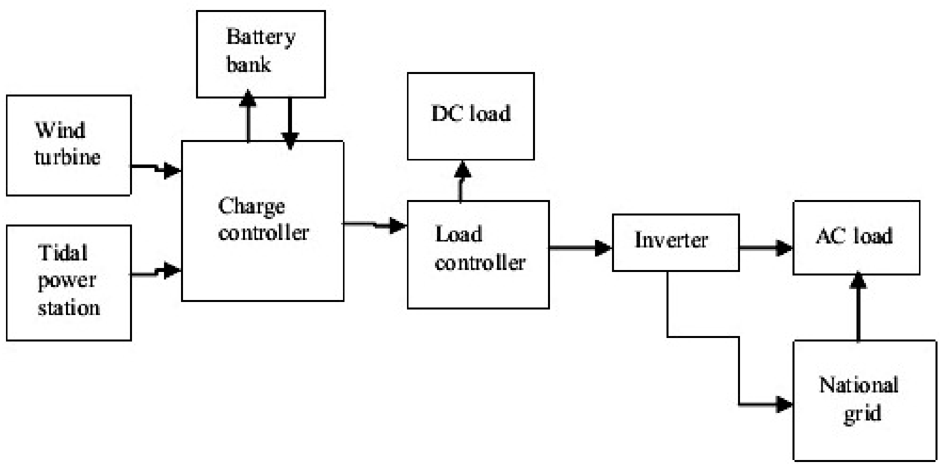


Figure 6: Proposed Hybrid Power System

Since our shortage is 463 MW, in this paper we are trying to achieve that power using our hybrid power system. As we are using Wind Turbine we need to consider the fact, that capacity factor of a wind turbine is around 40%. We considered a 100 MW wind turbine system which consists of 1000 small turbines of 100KW each. Each 100 KW wind turbines cost is BDT 88 (lakhs), which when totalled becomes BDT 880(Cr.) and the area required for this case is 17, 49, 000 m^2. From these wind turbines we will harness around 40MW, which still lacks 423 MW. In this situation we used Tidal Energy Resource to meet the existing load. We proposed to use 430 MW Tidal Barrage Power Station which will cost BDT 1792 (Cr.). It consists 43 generators and the length required for this case is around 1.4 Km long. Our consideration about the height of the Wind turbines is to be 50 m high from sea level. We considered the higher heights due to the availability of the greater wind speed.

Since the Sandwip, which is an island of 50 km long and 5 -15 km wide, which is a suitable location for the generation of power using Tidal Energy [2]. We can easily build a tidal barrage power station there.

Table 3: Total Installed capacity, Installation cost (Tk.), Area required for the Hybrid power system.

Sl. No.	Type of resource	Installation capacity (MW)	Turbine or Generator required	Total area/length required	Per MW Cost Tk. (Cr.)	Total cost required Tk.(Cr.)
1	Tidal energy	430	43	1.5 Km	4.1667/=	1792/=
2	Wind energy	100	1000	17,46,000 m^2	8.8/=	880/=
Total installation capacity (MW)		**530**			**Total cost Tk.(Cr.)** :	**2672**/=

5. Conclusion:

Hydrocarbon resources are reducing such a way, which is a matter of time when there will be no more. So alternative solution is must needed. In another sense they are the main cause for environment pollution, whereas wind and tidal are all natural sustainable energy with no pollution. Our government should take some immediate steps to use these two important elements of the nature. Due to low running cost, these power plants are the future because the other ways are quite expensive. We have a very long coastal zone which if we use, can give us a lot, but we are still too slow to harness power from them. Since our country lacks about 463MW power, we thought with the use of tidal and wind resources we can meet the required power. We used tidal as our main source and wind is to take the rest of the required power. We calculated the cost and land for the installation of the hybrid renewable system. With our proposed hybrid power system it will be a cost effective and reliable solution or minimization of the current energy crisis. The green energy of the nature must take place the current position of those Hydro-Carbon resources. We may use the power of nature to keep the environment clean and healthy for all of us.

There still need some research work to make the system:

- More reliable
- Cost effective and improve efficiency
- Developing the wind turbines which may low sound
- To make the system more Eco- friendly
- To add some more sustainable energy resources (High efficiency Solar PV module, Biogas etc.) to the system

6. REFERENCES:

[1] Md. Zakaria Mahbub, Husnain- al- bustam, M. M. Suvro Shahriar, T. M. Iftakhar Uddin, Md. Abrar Saad, Comparison between conventional power generation and renewable energy power generation in Bangladesh, IJERA ,vol. 2, issue 2, Mar-Apr 2012-09-15

[2] Tausif Ali , Muhammad Omar Faruk , Sabuj Das Gupta, Kamrul Hasan ,Perspective and prospect of tidal energy in Bangladesh, IJSER, vol.3, Issue 7, July 2012

[3] Tidal power, Wikipedia, http://en.wikipedia.org/wiki/tidal_power

[4] Tidal barrage, Wikipedia, http://en.wikipedia.org/wiki/Tidal_barrage

[5] Tidal stream generator, Wikipedia, http://en.wikipedia.org/wiki/Tidal_stream_generator

[6] Wind power, Wikipedia, http://en.wikipedia.org/wiki/Wind_power

[7] BPDB, http://www.bpdb.gov.bd/bpdb/