Study of Present Scenario of Tidal Power energy and Generation in Bangladesh

A Thesis Submitted In Partial Requirements for The Degree of Bachelor of Science In Electrical and Electronic Engineering

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CERTIFICATION

This is to certify that this thesis work entitled "**Study of Present Scenario Tidal Power energy and Generation in Bangladesh**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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Dedicated to

OUR

PARENTS & TEACHER

WITH LOVE AND RESPECT

DECLARATION

We do hereby declare that this thesis is based on the result found by ourselves. This thesis is submitted to Daffodil International University for partial fulfillment of the requirement for the degree of B.Sc. in Electrical and Electronic Engineering. This thesis neither in whole nor in part has been previously submitted for any degree.

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ABSTRACT

Tides are caused by the catching forces between the divine bodies of the Sun, Moon and Earth, which cause the sea waters to rise and fall. As technology advances, the utilization of electrical and electronic gadgets grows tremendously, necessitating the assembly of additional power to satisfy future demands. Tidal energy is one among the foremost promising renewable energy sources currently available. Tidal energy is non-polluting and renewable. due to these characteristics, it's unique and fitted to future use as an influence generating source. round the world, differing types of tidal power plants exist, each with a special tidal elovation. additionally, the mechanism of converting tidal energy into electricity varies by location. However, the method wants to capture energy from tides is usually just like that utilized in conventional hydroelectric power plants. The tides at several areas throughout the planet and along the Indian coast are going to be studied from the literature, as will tidally power plants across the planet, resources allocations for tidal power plants, and therefore the advantages and drawbacks of tidal power. Tidal energy is an old yet effective approach among them. Because tide is driven by the orbital mechanics of the systematic and are deemed limitless within a person's timeline, tidal power is considered a renewable energy source. Tidal power energy is additionally a pollution free source of energy of tons of promise. Tidal power might be a viable alternative to satisfy the present electricity shortage. Ocean wave and tidal power, with correct design, siting, deployment, operation, and maintenance, might be one among the foremost environmentally friendly electricity generation systems ever produced.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Tidal energy is a build of energy produced by the naturally ebb and flow of the tides through the gravitationally influence between the earth, moon and the sun. Tidal current with enough energy for harvest occurs when water flows through a bot neck, which makes the water move faster. Specially designed generators in suitable locations, the tidal energy can be converted into usable forms of energy including electricity. Other forms of energy can also be extracted from the sea, including waves, sustained ocean current, and temperature and salinity in seawater.[1] Tidal power, also familiar as tidal energy is generated by transforming the energy of the tides into useable types of energy, mostly electricity, using a variety of ways. Tidal energy has the potential to supply power within the future, despite its lack of wide spread application. The wind and therefore the sun are less reliable than the tides. Tidal energy is more powerful than wind because water is many times denser than air. due to its density, it's more efficient than wind or solar power and creates no greenhouse gases or other waste, making it an appealing renewable energy source to explore. the foremost significant impediment to tidal energy is that the high expense of constructing tidal power stations. Another important source of concern is the possibility of detrimental environmental consequences for marine life. Spinning blades, as well as water fouling caused by other system components, can harm living organisms.[2] The Karna Fuli Hydro power station, with a generating capacity of 230 MW, is Bangladesh's sole hydro power station. Despite the very fact that Bangladesh's government has prioritized the utilization of renewable energy, there's currently no tidal generating within the country. With a population of about 160 million people, Bangladesh has long been in need of electricity. Bangladesh's energy problem has reached critical proportions, and electricity generation is now the government's main concern. to deal with things, the govt has implemented programs to reinforce electricity generation. But it's evident that within the near future we've to modify from fuels to renewable sources of energy for power generation. In this study, we present the energy and generation of tidal power and explain that Bangladesh has a tremendous potential for exploiting tidal sources for power generation, which should be fully exploited. Tidal energy technology is frequently utilized with other reliable energy sources. Bangladesh has a vast coastline with tidal heights ranging from 2 to 8 meters. This height is adequate for supplying power. [3]

1.2 Objective:

The interaction between the earth, the sun, and hence the moon, which causes the natural rise and fall of tides, might be referred to as tidal energy. Recurrent event currents with enough energy to gather occur when water flows past a constriction, forcing the water to go faster. recurrent event energy is additionally remodeled into usable sorts of power, like electricity, victimization properly created generators at applicable places. alternative kinds of energy are additionally created by the ocean, like waves, persistent ocean currents, and temperature and salinity changes in brine. Locations with wide fluctuations in recurrent event vary, or the difference between high and low tides, and wherever recurrent event channels and waterways get narrower and recurrent event currents become stronger area unit smart candidates for gather recurrent event energy. because the world's want for clean power, renewable fuels, and important materials for energy and industrial processes rise, it's additional necessary than ever to hunt out and secure long-run energy supplies. Researchers have recognized the ocean's large potential for manufacturing reliable, renewable energy for a spread of applications. Waves, tides, and ocean currents have the potential to form enough electricity to power voluminous homes, in step with the Department of Energy's Water Power Technologies workplace. recurrent event energy is harder than wind energy because water is denser than air, delivering multiple additional power at an identical rotary engine diameter and rotor speed. recurrent event energy is additionally additional constant and sure than wind or energy, which area unit each intermittent and unpredictable. As a result, recurrent event energy might be a desirable renewable energy supply to research. the matter is to make capturing and changing the energy into useable power at scale financially viable, likewise on establish uses for recurrent event energy that area unit less value sensitive than national grid electricity. To completely exploit tidal energy as a considerable and continuous source of renewable energy, researchers must check out ways to assist develop technology and procedures which will make it more viable for commercial use. the world remains in its infancy, with several challenges to beat before it can develop and prosper during a sustainable manner.

CHAPTER 2
DEFINATION OF TIDAL

2.1 Work Principle:

Tidal power may be a sort of hydroelectric generation during which the water resource is replenished by tidal movements. it's truly renewable green power and clean source of energy creating no pollution and thereby helping to scale back greenhouse emission emissions, which is straightforward, reliable and predictable. The twice-daily difference in water level induced by the gravitational pull of the Moon and, to a lesser extent, the Sun on the world's oceans is utilized to generate tidal power. The interaction between the Sun and therefore the moon the rotating Earth leads to the ocean's water bulging upwards called Tide. Tides are the everyday motions of the ocean, with two high tides every 24 hours and 50 minutes, with each rise and fall storing an incredible amount of P The energy of the tide's springs from the earth's rotating energy. the facility of fluctuating tides, referred to as tidal range, is employed to get tidal power (difference between height of high water and low water point). By constructing a dam across a coastal bay or estuary with considerable variances between low and high tides, this tidal fluctuation in water level could also be to get energy. The water rushes into the bay during high tides. When the water level reaches its maximum height, the dam's gates close. The water flow generates enough energy to drive the turbines, which generate electricity. The generation of electricity from tides is extremely almost like hydroelectric generation, except that water is in a position to flow in both directions and during this way electricity are often created utilizing two-way turbines. Three chambers of an enclosure generate power in sequence,

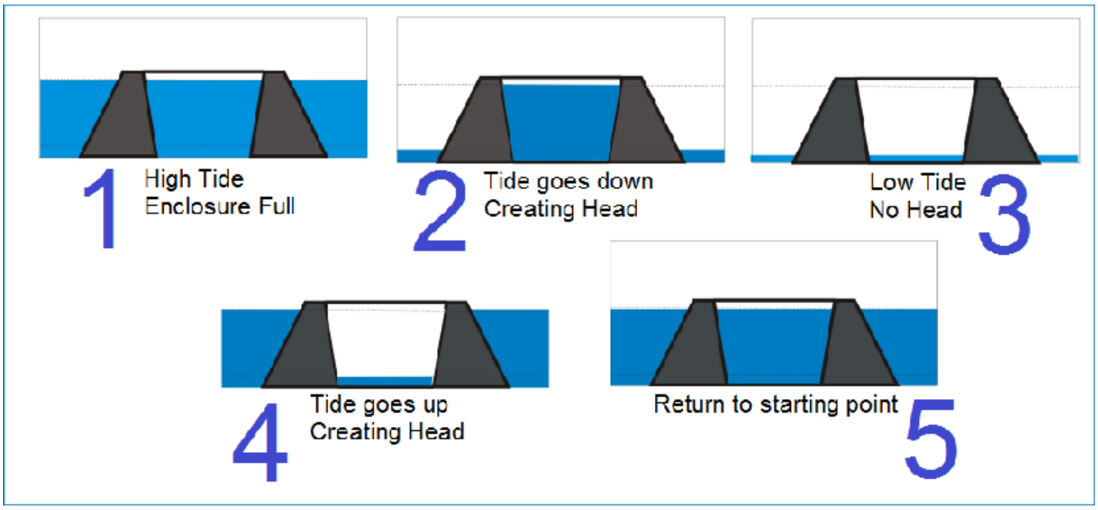

Fig. 1: Tidal power generation cycle

The sequence is often optimized to satisfy the requirements of the operator. for instance, if the necessity is for max output, only at very high and low water periods do all three enclosures generate electricity. If the operator requires endless output, the chambers will create in sequence, lowering overall output but maintaining power. The operator values the selection of continuous power. the lack to make on demand has hindered other sources of renewable energy. The amount of electricity generated is influenced by the tidal range's magnitude. The output is proportional to the tidal range squared. To put it another way, if a tidal range of x produces an influence output of y, a tidal range of 10x produces a power output of 100 year. The output of the facility is then linked to the world of the impoundment structure, which determines the amount of water that passes through the turbine during each generating phase. In comparison to other types of generators, hydroelectric generators are incredibly efficient, and the larger the generator, the higher the efficiency. [4]

2.2 Classification of Tides

2.2.1 Tidal Steam:

Tidal streams are large quantities of water that flow rapidly thanks to the tide's motion and are manifested as tidal flow. tidal river devices attempt to capture energy from the kinetic movement of water within the same way as wind turbines do from the movement of air. Although the technique is like that utilized in wind energy, there are key variances. Because water is 800 times denser than air and flows at a significantly slower rate, the turbine is subjected to much greater forces and moments. The turbines must be ready to generate electricity during both ebbs and flows of the tide. to get electricity efficiently, tidal river velocity of greater than 2 m/s are necessary.

2.2.2 Stream Type Tidal Power Calculation:

The power available from kinetic systems can be expressed as:

$$\mathbf{P} = \frac{\mathbf{pAV^2}}{\mathbf{2}}\mathbf{C_p}$$

Here,

P = amount of the power generated (in watts).

p= the density of the water (1027 kg/m3 for seawater).

A = the turbine's sweep area (in m2).

V = the velocity of the flow.

CP= The turbine power coefficient is denoted by CP.

2.2.3 Tidal Range:

The vertical difference in height between the high tide and the following low tide is known as the tidal range. To capture the tide, artificial tidal barrages or lagoons could be built. Barrages are basically dams that run the length of a tidal estuary. This is frequently the case when a dam or barrage is built over an estuary or bay with sufficient tidal range. For the barrage to be practical, the tidal range must be more than 5 meters. Calculation of Range Type Power.

The potential energy contained in a volume of water is:

$$\mathbf{P = \frac{1}{2} Agh^2}$$

Here,

The vertical tidal range is denoted by h.

The horizontal area of the barrage basin is denoted by the letter A.

ρ is the density of water = 1025 kg per cubic meter.

The acceleration due to gravity on Earth is g, which equals 9.81 meters per second squared.

The average potential power for one tidal period becomes:

$$\mathbf{\overline{P} = \frac{pAR_2 g}{2T}}$$

When the basin's surface area remains constant A.

ρ is the density of water.

The tidal range is denoted by R.

The energy is averaged across the tidal period T in this case. [5]

2.3 Generation of tidal energy:

Tidal power is that the sole source of energy that comes directly from the Earth–Moon system, and to a lesser degree, the Earth–Sun system's relative movements. The tides are generated by tidal forces produced by the Moon and Sun, together with the Earth's rotation. Other energy sources, such as fossil fuels, conventional hydropower, wind, biofuels, wave power, and solar, are all derived indirectly from the Sun. The relative motion of huge bodies of water is used to extract tidal energy. The gravity of the Sun and Moon causes periodic variations in water levels and related tidal currents. The shifting locations of the Moon and Sun relative to the world, the consequences of Earth rotation, and therefore the local topography of the ocean bottom and coasts all contribute to the magnitude of the tide at a given area. Tidal power is nearly infinite and considered a renewable energy resource since the Earth's tides are ultimately caused by interaction with the Moon and Sun, also because the Earth's rotation. This phenomenon is employed to make power employing a tidal generator. The potential for tidal power generation could also be greatly increased by increasing tidal variation or tidal flow velocities. thanks to pumping of water via natural constraints around coasts and subsequent viscous dissipation at the seabed and in turbulence, the movement of the tides produces endless loss of energy within the Earth–Moon system. The Earth's rotation has slowed during the last 4.5 billion years as a result of this energy loss. Over the last 620 million years, the Earth's rotating period has increased from 21.9 to 24 hours, resulting in a 17 percent loss of rotational energy. While tidal power might remove more energy from the system, increasing the rate of slowing, the effect over millions of years would be negligible. [6]

2.4 Electrical power from tidal flow:

Harnessing the facility of the tides are often achieved by placing bi-directional turbines within the path of the tidal water flow in bays and river estuaries. To be durable, it needs an outsized tidal range and involves creating a barrier across the bay or estuary to funnel the water through the turbines because the tide comes in and goes out. Fig. 2 gives a schematic diagram for electric power from tidal current. [8]

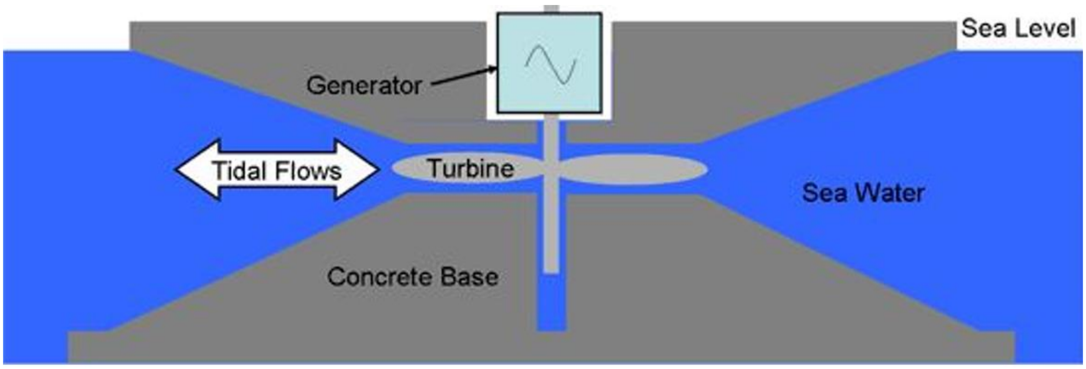

Fig. 2: Electrical power from tidal flow

2.5 Present scenario of tidal power in Bangladesh:

Bangladesh covers an area of 147,570 sq km which extends from 200 34’ N to 260 38’ N latitude and from 880 01’ E to 920 41’ E longitude; maximum extension is about 440 km in the E-W direction and 760 km in the NNW-SSE direction. Bangladesh recently received assurances over 118,813 square kilometers of territorial sea [5]. Bangladesh has a 200-nautical-mile exclusive economic zone and open sea access, which prevents it from becoming a "sea-locked country." The southernmost section of Bangladesh is bounded by the Bay of Bengal's 710-kilometer-long coastline, which features a ocean floor with a depth of up to 50 meters and an area of around 37,000 km2 with a tidal rise and fall of 28 meters. consistent with the Bangladesh Power Development Board, the country's installed generation capacity is 12,780 MW, with 18 power stations with 50 units (of which 30 are gas-fired, only 2 are coal-fired, 5 are hydro, and therefore the rest are oil-fired) within the public sector and 27 power stations with 38 units under Public Private Partnership (PPP) within the private sector. However, this is insufficient to meet our energy needs. The majority of facility stations in our country travel by gas, thus the pace at which the resource is consumed is extremely high. If the current pace of decline continues, it will only be a matter of time before the gas reserves are depleted significantly. [9] Gas is the most important source of energy in the country, accounting for roughly 72 percent of total commercial energy consumption and 81.72 percent of total electricity generation. [10] In order to get out of this difficulty quickly, the government has begun to use rental power plants, which are temporary and rapid, and are also regarded to be beneficial to the government. [11] Hiron Points, Sundari Kota, Mongla, Char Changa, Cox's Bazar, Galachipa, Patuakhali, Sawndip, Barisal, and other coastal places in Bangladesh have numerous potential locations for constructing a big tidal power station.

The Probability of Power Generation from Tide in Bangladesh is shown in Table 1:

Name Of the Station	***Tidal Range***	***Output Power (MW)***
Sawndip	4.55	28.84
Cox's Bazar	5.64	12.82
Hiron Points	2.80	8.83
Golachipa	3.56	12.98
Patuakhali	3.56	12.82
Barishal	3.90	14.36
Sundorikota	6.68	21.56
Mongla	5.9	21.73
Char Changa	5.7	28.86
Total		**162.8**

Table 1. Possible power generation stations and calculated output

But among all of them Sawndip is the best spot for barrage type tidal power generation. There is a geographical reason behind this: Sawndip is an island along the south-eastern coast of Bangladesh. Sawndip, however, is the finest location for barrage-type tidal power generation of all of them. There's a geographical explanation for this: Sawndip is a Bangladeshi island off the country's south-eastern coast. Sawndip is a Chittagong district sub-division located at 220 4905130' N and 910 421185' E, at the mouth of the Meghna River on the Bay of Bengal, separated from the Chittagong coast by the Sawndip Channel. [12] With a total area of 762.42 square kilometers, the island is 50 kilometers long and 5-15 kilometers broad. The tides in Chittagong Division are mostly semidiurnal, with a large range of variance due to the seasons and the maximum south-west monsoon. In 1984, an attempt was made by the Electronics and Electrical Engineering Department of Bangladesh University of Engineering and Technology to assess the feasibility of tidal energy in the coastal regions of Bangladesh, especially at Cox's Bazar and at the islands of Mahesh Khali and Kutubdia.[13] The average tidal range was found within 4-5 meters and the amplitude of the spring tide exceeds even meter. From different calculations, it's anticipated that there are variety of suitable sites at Cox's Bazar, Mahesh Khali, Kutubdia and other places where permanent basins with pumping arrangements could be constructed which might be a double operation scheme. [6]

2.6 Advantage of tidal power:

The first benefit of tidal energy is that ocean currents have a high energy density. The density of seawater is 832 times that of air, resulting in an 8-knot current wind. The second benefit of the tidal energy turbine design is that it allows the turbine to catch the K.E. of the flowing water to the maximum extent possible. It is conceivable to meet electricity demands in the gigawatt range by connecting 'Ocean Class's Hydro Turbines (7-14 MW each) in succession over an ocean passage. it's possible to satisfy less energy loads. Tidal Power's Benefits The high energy density of ocean currents is that the initial advantage of tidal energy. Because seawater is 832 times denser than air, an 8-knot current has an equivalent K.E. as a 390 km/h wind. The second advantage of the tidal energy turbine design is that it allows the turbine to gather the K.E. of the flowing water to the best extent possible. Tapping this power, can satisfy electricity demands within the multiple-gigawatt range by linking 'Ocean Class's Hydro Turbines (7-14 MW each) serial across an ocean passage. The 'Mid-Range' 250kW power grid may meet smaller energy requirements in off-grid settlements, isolated industrial sites, and regions with established net metering rules. Another advantage of tidal energy power production is that it's almost like other ocean energy extraction technologies, PV systems, and wind generation generation therein it doesn't utilize fuel to get electricity and doesn't create greenhouse gases. the most benefits of tidal power include: renewable energy that needs no fuel or oil, simple operation and maintenance, suitability to be used in remote locations, non-polluting and almost silent operation, ability to adapt to site conditions, design for local manufacture and maintenance, and therefore the ability to work almost 24 hours each day without a full charge time attended. However, tidal barrages can significantly alter the ecology of the basin. They can, however, provide advantages like flood protection, road crossings, marinas, and enhanced tourism. Tidal power plants provide a singular chance to manufacture clean hydrogen, dubbed "The Fuel for the longer term ," by electrolysis, particularly during non-peak operations and when there's excess power generated, or if the plant isn't connected to the grid.

The different advantages of tidal energy are discussed below:

2.6.1 Economics:

Over the years, tidal power has been exploited to a limited extent, but it's only recently that any substantial attempt has been made to understand its tremendous potential. Today, tidal power sites are often found during a sort of locations round the world. Once installed, tidal power can deliver exceptionally low prices per Kw/hr (negligible), despite its large initial cost.

2.6.2 Renewable:

Tidal power is actually renewable, even though it isn't fully solar (it is largely moon power). The tides will continue to run long after fossil fuels are gone. In a post-Kyoto world, this is becoming increasingly crucial.

2.6.3 Predictable:

Tidal electricity, unlike wind and solar PV, is totally predictable. As a result, it's the potential to be used as a Base-load power supply (much like hydro) that's immune to climatic and human demands. the number of electricity generated, for instance , is proportional to the dimensions of the tidal range. The output is proportional to the square of the tidal range; for instance , if a tidal range of x produces an influence output of y, a tidal range of 10x produces an influence output of 100y. the quantity of water browsing the turbine during each producing phase is additionally closely tied to the world of the impoundment structure, which successively determines the facility production. as compared to other forms of power generation, tidal power generating equipment is additionally quite efficient, and therefore the larger the facility generating equipment is, the higher the efficiency. A key feature of energy delivery is continuous power generation that keeps pace with demand. This is usually accomplished by running base-load generation equipment continuously and supplementing it with peak-load generation equipment during peak hours. Nuclear power plants are a base load kind of power since they cannot be turned down fast and operate 24 hours a day. Although fossil fuels are simpler to shut down, when demand for energy drops at night, they normally release the steam into the atmosphere. Tidal power, on the other hand, is a source of energy that can be turned off and on fast without causing significant efficiency losses. [7]

2.6.4 Useful Long Term:

Tidal power has a lengthy life span, up to 120 years in certain cases. Tidal power equipment, like hydroelectric turbines and generators, is exceptionally durable and efficient. Monitoring technology is capable of detecting even the tiniest variations in operation, and changes are performed instantly, eliminating downtime. Dams constructed under the Roman Empire are still operational today. Hoover Dam began generating electricity in 1936 and remains operational with no signs of impending breakdown. [4] [15] Tidal Electric's tidal generator, consistent with Tidal Electric, will survive for several years, significantly longer than the standard 20 to 30 years anticipation of other forms of power generation. the value of power once the capital expenses are paid off in 15 or 20 years is simple to predict because the tidal generator consumes no fuel and requires minimum maintenance: almost $0. The world's largest tidal power plant, at La Rance on the coast of Brittany, features a civil construction design lifetime of 120 years. The turbines have a 40-year maintenance cycle. The turbines are now being gradually reconditioned in compliance with the forty-year maintenance refurbishment cycle.

2.6.5 Capital and operating costs:

Despite being located in a maritime environment, tidal power plants are low-maintenance constructions with minimal running costs. Barrages, like sea walls, are planned and built to withstand the severe conditions of the sea. Gate structures are primarily radial or vertical-lift gates, which are suited for the maritime environment and are quite straightforward to operate. The generators require little maintenance since they are cooled by the sea, while the turbine blades last a long time because they are slow to turn and function in a fluid environment. A tidal power plant's capital expenses are like those of other power sources, and therefore the generated electricity is a smaller amount expensive. Although the development expenses are greater, the operational costs are much lower. In terms of operational expenses, Tidal Electric's tidal generator is extremely cost-effective: fuel accounts for 35% of operating costs for fossil fuels, while pollution controls and regulatory compliance account for 25%. The Tidal Electric tidal generator's availability is going to be substantially higher, leading to a big increase in production (ie. one hundred pc for tidal vs. 82 percent for fossil fuels or 58 percent for nuclear due to the plant's residual value after capital expenditures are paid, the lengthy usable life effectively reduces the cost of capital. However, if the engineering framework is already in situ, capital costs are cheaper (e.g., coastal embankment and sluice gate in Bangladesh to guard the coastal people from the natural disaster). generally, the lower the capital expenses per unit capacity, the larger the project. As a result, larger projects are going to be more cost effective than smaller initiatives. The capital expenses per kilowatt capacity at 100 MW are anticipated to be between $1200 and $1500. At US$.005 per kWh, operating costs are extremely low.

2.6.6 Continuous output:

The tidal power technology may be improved to suit the demands of a continuous power source. If maximum output is required, all enclosures of tidal power plants may provide tidal energy at severe high tide and extreme low tide times, for example. If a continuous output is required, the chambers will create in sequence, limiting overall output but delivering continuous power. For the local needs, the continuous power option is critical. The operator of a tidal generator may match the output curve to the demand curve and use it to supplement current generation or stand alone as a power source. [14]

2.6.7 Hydrogen Storage:

Electricity is produced continually at tidal power plants. Electricity cannot be utilized at the same rate all of the time hence it is used at a reduced rate during night. As a result, some power will be used in excess at points during its day-cycle. Electrolysis might be utilized to produce hydrogen with the extra power. Environmentalists and planners within the us, Japan, the, variety of European nations, and variety of other countries are now investigating hydrogen as a possible car fuel. Tidal Electric Inc.'s Alaska project intends to use extra electrical output to hydrolyze water and generate hydrogen gas, which can be stored and want to power fuel cells during times of low output. there's a big reduction in total mechanical efficiency, but this approach has economic justification because it employs extra capacity to supply hydrogen. In rural Alaska, where there are few highways and little local grids with no interconnections, hydrogen as a data-storage medium is especially appealing. Ships can deliver hydrogen to remote areas, where it's going to be utilized in fuel cells for house heating, energy, and transportation. The creation of hydrogen is a side benefit of tidal power generating. [16]

2.6.8 Replacing the Nuclear power dependency:

The world's 333 nuclear power reactors are all becoming older, and several are on the verge of being decommissioned or requiring costly malignance. [17] Many wealthy countries do not wish to rely on nuclear energy at the moment. Sweden has decided to phase out nuclear power reactors by 2010. [18] Pollution and global warming are of diverse public and commercial concern, but profit is a universally powerful drive. Businesses will go to the lost source when considering how to replace outmoded and uneconomic producing capacity, and tidal power is one such choice. Because tidal power's environmental benefits stimulate its deployment and increase its economic appeal. Following the agreement on the Kyoto Protocol, all European nations, Jaan, the United States, and worldwide efforts have and prom opted the use of non-polluting, green, renewable-fuel technologies for power generation. Additional financial benefits, such as pollution credit's (clean development mechanisms, CDM),from fuel price increases, exemption from global Warming measures, and the overall stability and predictability of low-head tidal power, would appeal to decision makers.

2.6.9 Climate change global warming and sea level rise favour the tidal power technology:

If the greenhouse projections come true, the current issues will be drastically worsened. Because to sea level rise, the increasing intensity of all convective processes in the sky would increase the frequency and severity of tropical cyclones, tornadoes, s, floods, and storm surges in many regions of the world, posing substantial risks to all forms of property insurance. These tragedies extend the tidal range of the ocean, making tidal energy systems more effective. [19] Because the tidal range increases, sort of tidal energy system may provide more energy.

2.6.10 Tidal power may attract from oil importing nations:

Oil-importing countries are interested in tidal power since it would reduce or eliminate their reliance on imported fuels while also producing energy for export. Because of the Kyoto Protocol's principles, the majority of developed nations have agreed to cut their greenhouse gas emissions. Tidal energy will assist them in achieving the ideals and pledges made at the United Nations Conference on Environ met and Development (UNCED) in Rio de Janeiro, Brazil.

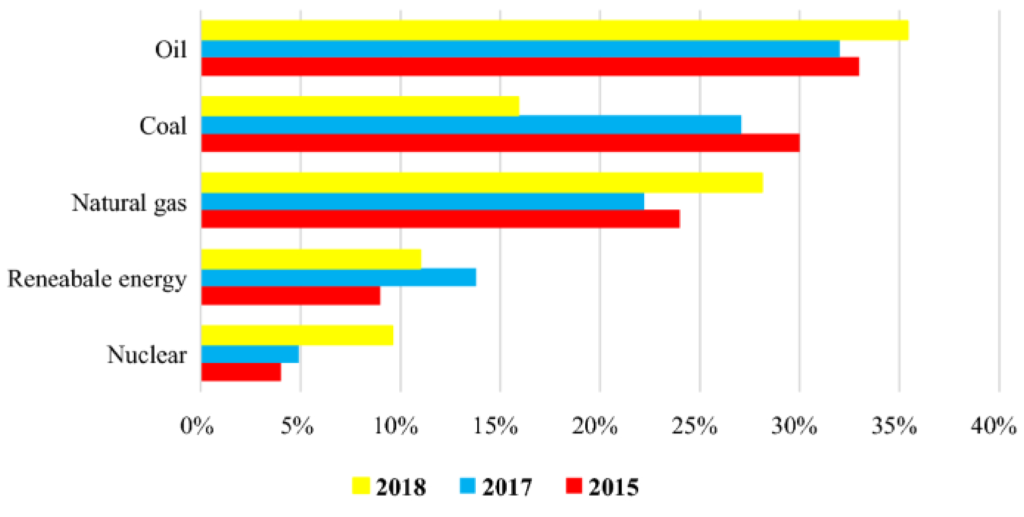

Fig. 3: Tidal power oil importing

2.6.11 Tidal power enhances the development of the tourism industry:

Tidal power is a type of renewable energy that is environmentally friendly. Tidal power may now be harnessed using ecologically friendly methods. On the other side, the global population is becoming more environmentally concerned, and the number of environmentally conscious individuals using green energy is growing every day. People now want to see and visit the location of true green energy technologies. As a result, tidal power plants have boosted the tourism business tremendously. In a same vein, the tidal barrage in Nova Scotia attracts 36,000 tourists every year (a figure comparable to that of several Caribbean islands), making it a beautiful but distant and frigid destination with a burgeoning year-round tourism industry. [20]

2.6.12 Developing countries need power:

Tidal Energy Is a Good Option: Developing economies are in critical need of electricity to power hospitals, schools, and put their human and natural resources to work. Estimates differ, but the demand for additional energy sources is enormous in every case. The increased demand for producing capacity diminishes these nations' environmental sensitivity, although the World Bank, OPIC, and other financial sources have been vigilant in monitoring environmental effect and encouraging non-polluting and renewable energy alternatives. Many tidal energy businesses have had significant conversations with many of these multi-national financing sources, and they are enthusiastic about tidal power as a source of commercial-scale electricity that will fit their policy objectives for non-polluting power sources. The World Bank, OPIC, IDB, and other multi-national lenders whose policy goals demand for lowering emissions and pollution are expected to enthusiastically promote tidal energy companies, notably Tidal Electric. [21]

2.6.13 Tidal power is used for air quality improvement and reduction of greenhouse gas:

Because tidal power may be a clean green source of electricity, it significantly improves air quality. quite 30,000 people in Pennsylvania, the us, have switched to renewable energy like tidal energy, which is like removing 51,000 cars from the road or planting quite 28 million trees. Each family that buys renewable energy reduces pollution by planting 950 trees or not driving 20,000 miles. [22] At the top of June 2000, there have been around 16,000 clients within the UK who had signed up for a GP tariff. Only approximately 100 non-domestic users, including government, business, and non-governmental organizations (NGOs), structure the bulk of those clients. this is often barely 0.07 percent of all homes within the Uk . Total consumption equals 215 GWh of power per annum, leading to a carbon reduction of about 26,000 tones in 2000. These figures are shockingly low, especially in comparison to UK marketing research that found that "25 percent of domestic electricity customers, or 5.7 million households, would have an interest during a green electricity tariff, albeit it meant paying a touch quite rock-bottom prices to make sure their electricity comes from renewable sources”. [23] the increase of customer adoption has been estimated to range from 1% to 55%, counting on the market research. Green power markets, on the opposite hand, have seen 2% of households purchase green electricity4. Data-monitor, a marketing research firm, reportedly predicted that 250,000 UK consumers will move to GE by 20055. Green power is purchased by 140,000 homes within the Netherlands. The Kyoto Protocol established a clean development mechanism (CDM) to scale back greenhouse emission emissions by wealthy countries from developing countries. Carbon trading has become the preferred policy for quickly addressing global climate change in countries all around the world. The ongoing deliberations of the Kyoto climate accord, which could set limitations on greenhouse gas emissions, have sparked interest in many countries. Progress in international climate talks, new carbon trading systems in Europe, and personal sector trading activity in the United States and overseas are just a few of the reasons that greenhouse emission credit trading is gaining traction. Governments and corporations all across the world recognize the necessity of carbon trading if they're to unravel this issue within the most cost-effective manner feasible. [24] By the amount 2008-2012, 38 industrialized nations have agreed to reducing their greenhouse emission emissions by a mean of 5.2 percent below 1990 levels, as began within the 1997 Kyoto Protocol. Trading of emissions credits, earned by companies that exceed mandated emissions cuts, is one among the mechanisms promoted by the protocol for combating heating

2.6.14 Tidal power does not produce any waste:

Tidal energy generation would not necessitate waste disposal, nor would it result in 17 million tonnes of acidic emissions per year (the greenhouse effect). [25] The benefits of having the barrage in place have been found via work on environmental and regional concerns. These include the protection of a vast stretch of shoreline from storm surge tides (like the Thames Barrier does in the United Kingdom), a road crossing, chances for water-based leisure and amenity, higher property values, and significant job development. [30]

CHAPTER 3
POWER GENERATION

3.1 Power generation methods:

Tidal power can be classified into four generating methods:

- ✓ **Tidal stream generator**
- ✓ **Tidal barrage**
- ✓ **Dynamic tidal power**
- ✓ **Tidal Lagoon**

3.1.1 Tidal stream generator:

A tidal river generator is a device that captures energy from moving bodies of water, such as tides. Because they perform similarly to underwater wind turbines, these machines are often referred to as tidal turbines. Tidal river generators are the most cost-effective and environmentally friendly of the three main types of tidal power generation. TSGs (tidal stream generators) use the K.E. of flowing water to power turbines, almost like how wind turbines use wind to power turbines. These turbines are often horizontal, vertical, open, or ducted, and they are usually installed at rock bottom of the water column, where tidal velocities are highest.

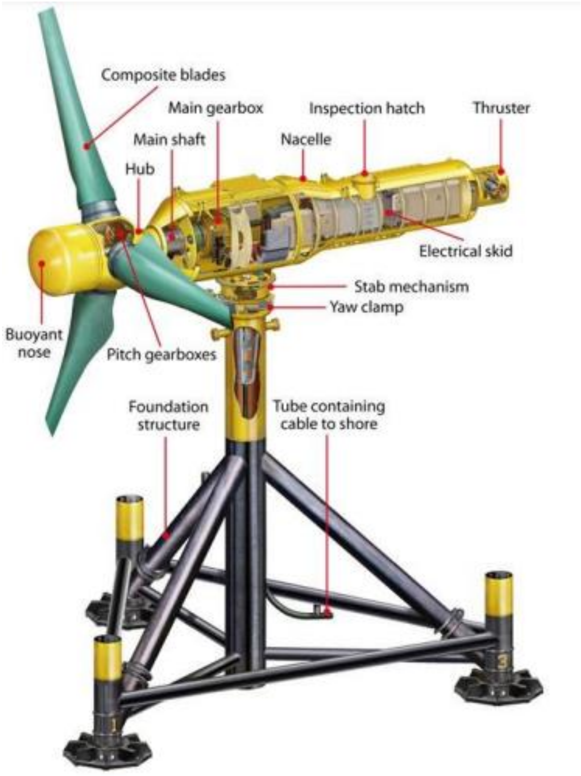

Fig.4: Tidal stream generator

3.1.2 Tidal barrage:

Tidal barrages take advantage of the potential energy contained in the height differential (or hydraulic head) between high and low tides. When tidal barrages are used to create electricity, the tide's potential energy is captured by strategically placing specialized dams. The brief increase in tidal force is channeled into a big ocean, with a perpendicular barrier at the far end, making a large 'T' shape, as the sea level rises and the tide begins to come in. This long T-dam would interfere with coast-parallel oscillating tidal waves that would rebasing behind the dam, storing a lot of energy. A tidal barrage is a dam-like structure that captures the energy from tidal water masses going in and out of a harbor or river. A tidal barrage, rather than damming water on one side like a typical dam, enables water to flow into the harbor or river during high tide and then releases it during low tide. This is accomplished by monitoring the tidal flow and operating the sluice gates at important tidal times. Turbines are then installed at the sluices to capture the energy that is generated when the water rushes in and out.

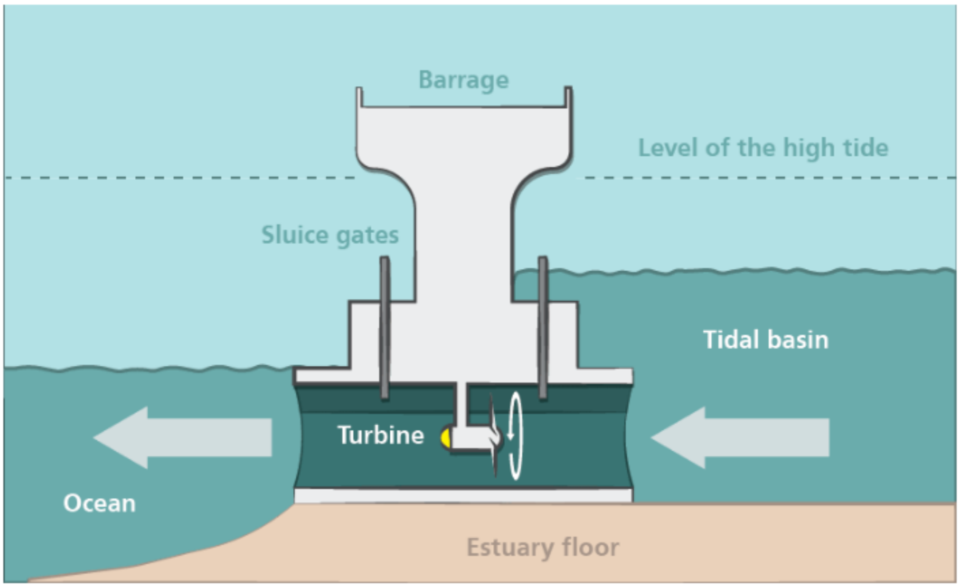

Fig.5: Tidal barrage

3.1.3 Dynamic tidal power:

Dynamic tidal power, or DTP, may be a novel and unproven way of generating tidal power. it might include the development of a huge dam-like structure that might run from the shoreline to the continental shelf's shores, containing tremendous hydraulic currents. Dynamic tidal power (DTP) may be a new yet promising technology that uses the interaction of potential and K.E. in tidal flows to get electricity. Tidal phase discrepancies are introduced across the dam, leading to a substantial water-level differential in shallow coastal waters – like those found within the UK, China, and Korea – with strong coast-parallel oscillating tidal currents.

3.1.4 Tidal lagoon:

Tidal pools are self-contained enclosing barrages erected on high-level tidal estuary land that trap and discharge high water to make electricity, with one pool generating roughly 3.3W/m2. Continuous power supply of roughly 4.5W/m2 could also be guaranteed by two lagoons running at separate time periods. Enhanced pumped storage tidal sequence of lagoons elevates the water level above high water and employs intermittent renewables for pumping, roughly 7.5W/m2 i.e. 10 × 10 km yields 750MW consistent output 24 hours each day , 7 days every week . These self-contained barrages don't obstruct river flow and are a feasible alternative to the Severn Barrage. Construction of circular retaining walls fitted with turbines which will collect the P.E. of tides may be a novel tidal energy design option. The reservoirs generated are like those created by tidal barrages, except that the world is artificial and there's no preexisting ecology. When completed, the projected Tidal Lagoon Swansea Bay in Wales, uk , would be the world's first tidal power plant .

Figure 6 shows images of several technologies (design) used in tidal power.

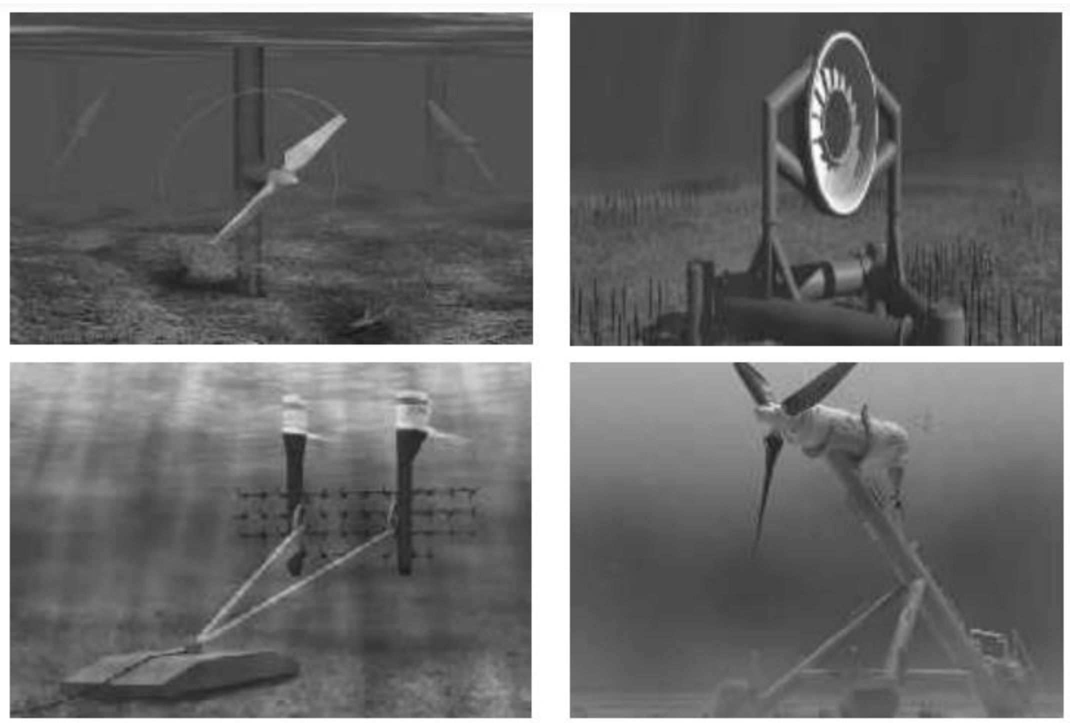

Fig 6: Various uses Developed for Converting Tidal Energy into Electricity *[5] [6*]

3.2 Methodology:

The following is an example of methodology for converting wave energy into electricity for the Floating Wave Power Vessel. The Floating Wave Power Vessel (FWPV), which is made sort of a ship, are going to be anchored in 50-80 meters of water. it'll have a maximum power output of 1.5 MW and produce about 5.2 million kWh per annum. The water from waves that travel up the slope front face is captured by this pattern. a standard Kaplan turbine returns the gathered water to the ocean . This is, in some ways , a flying Tapchan. [26]

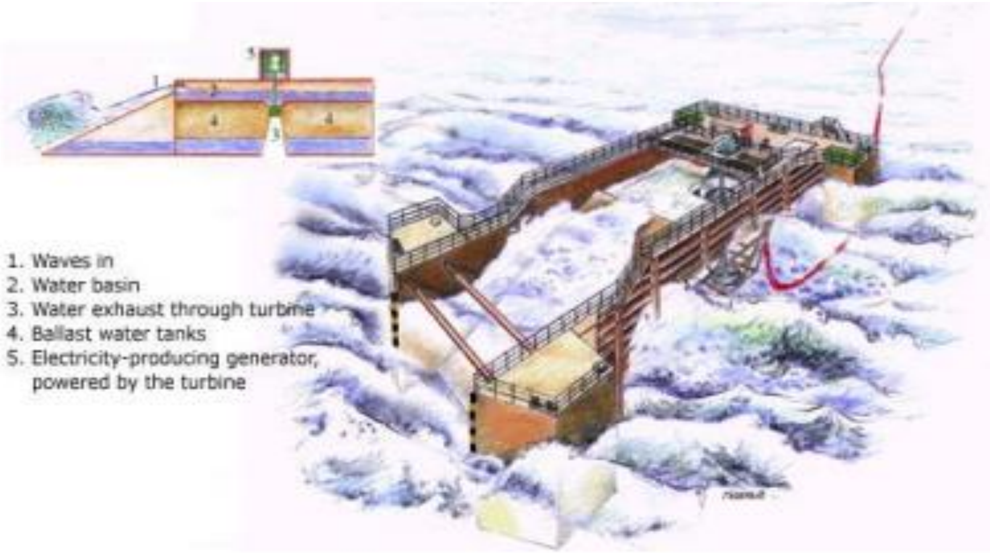

Fig.7: Floating wave power vessel

Methodology for converting Wave Energy into Electricity using the Stingray tidal river Generator

Engineering Business Ltd.'s (EB) in-house experience of developing subsea machinery was wont to make material selections. The project's timeline and budget constraints also had a big impact on specification. a billboard equipment, for instance , which will be within the water for an extended period would have a better amount of chrome steel components to face up to corrosion and permit for easier maintenance. However, during this project, a budgetary compromise had to be made, and painted steel pieces might be utilized in many areas for a fraction of the value of chrome steel . due to the machine's size, it had been designed to be readily weakened into major sections for transit by barge and re-assembly on site. The initial plans involved a dual hydroplane vehicle. to form manufacturing easier and save costs, this was reduced to one hydroplane design throughout the planning phase. one hydroplane could be constructed to possess equivalent overall performance to the optimal twin hydroplane machine produced, consistent with metric modeling of performance and price . [27]

3.2.1 Field trip

Hydrographic survey maps for the three locations were obtained from BIWTA before the four-member Team of Experts began their field tour to the suggested sites. [28] After visiting the Bagkhali River in Cox's Bazar and therefore the Pussur River within the Mongla Port region, locations on the survey map were marked. All of those survey charts, which illustrate the intended location for tidal and wave power generation, are retained in Appendix – A, B, and C. Mr. Maksud, AGO of Cox's Bazar, provided us with tidal data once we were collecting data from the Cox's Bazar Auto gauge station. At the time of picking locations along the Pussur River, Sr. Hydrographer and in-charge Chief Hydrographer of Mongla Port Authority, also as 2 Tide Watchers, provided us with tidal data from the Mongla Auto gauge station.[29]

Geographical locations of the proposed selected sites are given below in table 2:

Place	***River***	***Area***
A. Cox's Bazar	Bag Khali	Nania sara, Near BIWTA landing Station & Auto Gauge Station Lat : 200 59' - 30" N Long : 910 59' 29" E
		Moheskhali Channel Lat: 210 28' -32" N Long: 510 58' 30" E
		Laboni Point (Sea Beach) Lat : 200 25'- 00" N Long : 910 58' 00" E
B. Mongla	Possur	North Of Gulf Foods LTD Lat: 220 29' - 00" N Long: 890 35' 30 E
		Koromjol Junoid Khal (Forest Office) Lat: 210 59' - 30' N Long : 880 30' 00" E
C. Sawndip	Satal Khal	Sawndip to Char Pia Lat : 220 28' - 00" N Long : 910 26' 00" E

3.3 Capacity value:

Table III shows the monthly average electricity generation produced from the resource and generation model, showing that the maximum 206 MW power can be created in August and a total of 115.73932 MkWh (Million-kilowatt hour) energy can be generated in a year. If this project is realized, BPS's power issue will be greatly alleviated.

Monthly possible generation capacity table 3:

Month	***Power Output (MW)***	***Energy (MkWh)***
January	140	7.378
February	142	6.3616
March	148	8.88
April	165	9.405
May	196	10.45072
June	198	10.692
July	105	13.776
August	206	12.1334
September	198	9.6465
October	185	10.8965
November	167	8.8176
December	151	7.302
Total		**115.73**

According to the Yearly Report of the facility Grid Company of Bangladesh (PGCB), Bangladesh's annual net energy generation in 2010-2011 was 27646 MkWh, and therefore the computed energy generation from this proposed project is 115.73932 MkWh, or 0.42 percent of overall generation within the same year. [29] As a result, tidal generating can minimize load shedding and improve system reliability.[32]

3.4 Collection of auto gauge data:

For the period of spring and neap tides, we gathered gauge data from Cox's Bazar and Mongla gauge stations. We compute tidal ranges using this information. Tidal ranges at Mongla's Pussur River and Cox's Bazar's Bagkhali River will meet our anticipated energy generation needs.

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Collected data and their tidal ranges are shown below table 4:

A. Cox's Bazar (Bagkhali River)					
Spring Tide- Tidal Range			**Jul-17**		
Date	Time	High Tide Meter	Time	Height (Meter)	Range
7- Jul-17	11.30	4.06	18.00	2.3	2.85
8- Jul-17	12.00	4.03	17.20	1.33	2.69
9- Jul-17	14.30	3.9	19.30	1.29	2.9
10- Jul-17	18.00	0.77	5.25	0.83	0.24
11- Jul-17	12.50	4.43	19.30	0.92	3.22
12- Jul-17	13.20	4.53	5.00	0.95	3.37
13- Jul-17	14.50	4.07	7.00	0.8	3.18

International Journal of Scientific & Engineering Research Volume 3, Issue 12, December-2018 1 ISSN 2229-5518:

Collected data and their tidal ranges are shown below table 5:

A. Mongla Auto Gauge Station (Pussur river)						
Gauge Data: Data Collection (RL in Meter)						
Date	***Time***	***HW***	***Date***	***Time***	***LW***	***Tidal Range***
5-8-2017	0:30	3.95	5-8-2017	7:30	0.93	3.02
5-8-2017	12:10	4.24	5-8-2017	20:00	0.9	3.34
6-8-2017	0:50	4.1	6-8-2017	8:00	0.79	3.34
6-8-2017	12:30	4.28	6-8-2017	20:30	0.76	3.49
7-8-2017	1:10	4.21	7-8-2017	8.35	0.66	3.55
7-8-2017	13:10	4.34	7-8-2017	21:10	0.64	3.7
13-8-2017	4:15	1.25	13-8-2017	11.45	1:37	2.74
14-8-2017	0.00	1.25	14-8-2017	5:15	4.02	2.77
14-8-2017	0.35	1.45	14-8-2017	16:00	5.05	2.6

HIGH AND LOW WATER FROM (BIWTA Format)

Station:		Cox's Bazar		River:	Bagkhali			Month	June		
DATES	T AND H	HIGH WATER		LOW WATER		DATES	T AND H	HIGH WATER		LOW WATER	
		HHW	LHW	HLW	LLW			HHW	LHW	HLW	LLW
1	T	500	1715	1000	2345	16	T	1615	330	1015	2200
	H	321	321	160	125		H	308	308	159	133
2	T	615	1745	1230	0	17	T	500	1700	1115	1345
	H	341	335	155	0		H	313	297	157	133
3	T	800	1900	1400	15	18	T	600	1800	1300	0
	H	351	321	151	129		H	325	307	149	0
4	T	815	2000	1445	115	19	T	715	1900	1400	15
	H	363	325	135	125		H	351	307	119	115
5	T	900	2115	1530	200	20	T	800	2000	1430	130
	H	383	341	137	121		H	377	326	119	105
6	T	930	2145	1600	300	21	T	930	2130	107	215
	H	390	351	127	115		H	397	353	1600	94
7	T	1000	2215	1700	345	22	T	1000	2200	101	1700
	H	405	366	120	115		H	405	359	330	89
	T	1030	2230	430	1715		T	1030	2230	85	415

8	H	402	357	151	143	23	H	413	367	1700	73
9	T	1200	2330	1830	530	24	T	1145	2345	87	500
	H	399	345	119	113		H	423	375	1800	75
10	T	1200	0	1900	600	25	T	1215	0	91	600
	H	393	0	101	101		H	423	0	1900	85
11	T	1230	0	1900	630	26	T	1300	30	89	2000
	H	383	338	113	99		H	406	366	630	83
12	T	1300	30	1930	700	27	T	1400	0	90	2100
	H	374	334	123	103		H	390	0	745	90
13	T	1345	130	700	2015	28	T	1445	215	103	2115
	H	367	328	133	125		H	367	353	121	101
14	T	1430	200	800	2100	29	T	0	0	0	0
	H	353	326	149	132		H	0	0	0	0
15	T	1530	230	900	2130	30	T	0	0	0	0
	H	330	317	157	124		H	0	0	0	0

High and low water from show in below table 6. [7]

3.5 Possibilities of tidal power generation:

Tidal power is now knocking on the door of the future for energy generation. Tidal power was first used around approximately 900 AD, when early civilizations built tide mills. The tide was utilized to spin a waterwheel, which was then used to crush grain into flour in these mills. [36]

There are two main reasons for which Bangladesh has a great possibility in tidal power generation. They are:

3.5.1 Ocean victory:

Bangladesh now features a lot of potential in terms of tidal power generation. Bangladesh has lately obtained a huge ocean area from two neighboring nations, India and Myanmar. Bangladesh has won a serious triumph. Bangladesh has been granted rights to 118,813 square kilometers of territorial sea as a result of its ocean win. Bangladesh now features a 200-nautical-mile exclusive economic zone and unfettered sea access, preventing the country from becoming a "sea-locked country." [8] Bangladesh has sovereign rights to the utilization and exploration of maritime resources, including oil and gas, in its exclusive economic zone. This enormous sea-zone features a lot of which will be wont to generate power. [33]

3.5.2 Spot availability:

The first stage in building a tidal power plant is to choose a location. The generation of power from a tidal wave will be impossible without a precise place. As a result, the most critical component in establishing a tidal power producing facility is site selection. For tidal power generation, a coastal region with constantly strong tide waves (>5m) and appropriate for embankment should be chosen. For establishing a tidal power production plant, examine the stability of the chosen area, such as steady tidal waves, low risk of natural disasters, and so on. The location should also be far from the neighborhood and have a simple transformation mechanism. Bangladesh has a large number of potential sites for tidal power generating. Following ocean victory, there are numerous locations for building a plant, but the primary concern is to find the ideal location for a power plant that meets all of the criteria and offers all of the benefits, such as the availability of high tide waves, suitability for embankment, considerable stability, distance from locality, ease of transformation systems, and sufficient size to build a power plant. Hiron Points, Sundarikota, Mongla, Char Changa, Cox's Bazar, Golachipa, Patuakhali, Sandwip, and Barishal are only a few examples of coastal locations in Bangladesh. These locations are ideal for building a major tidal power plant and generating enough electricity from tidal waves.

Name Of the Station	*Tidal Range*	*Output Power (MW)*
Sawndip	4.55	28.84
Cox's Bazar	5.64	12.82
Hiron Points	2.80	8.83
Golachipa	3.56	12.98
Patuakhali	3.54	12.82
Barishal	3.90	14.36
Sundorikota	6.68	21.56
Mongla	5.9	21.73
Char Changa	5.7	28.86
Total		**162.84**

Table 7: *Probability of Power generation from tide in Bangladesh.* [34]

However, Sawndip is the finest location for tidal power generation of all of them. There is a geographical explanation for this. Sawndip is a Bangladeshi island off the country's south-eastern coast. Sawndip is a Chittagong district sub-division located at 22.490513oN 91.421185oE. It is located on the Bay of Bengal, near the mouth of the Meghna river, and is separated from the Chittagong coast by the Sawndip strait. With a total size of 762.42 square kilometers, the island is 50 kilometers long and 5-15 kilometers broad.

Fig.8: sky scenario of Sawndip from google map.

With a tidal fluctuation of 5-6m, Sawndip offers a lot of potential for tidal power generation. There is a flood control barrage that runs the length of the island, with 28 sluice gates. Sawndip can create a considerable quantity of electricity, roughly 16.49MW, because each sluice gate can support one turbine and one generator. [35]

Parameter	***Value***
Tidal Range	4.67m
Num. of sluice gates	29
Num. of turbine uses	05
Basin area	4*106 m2
Construction Time	4 Years
Cost	US $ 10.37 Millions
Output Power	16.49 MW

Table 8: Summarized of Sawndip project.

3.6: Advantages:

It is currently popular in many nations throughout the world due to its numerous benefits. The cost of a tidal power plant is low, and it requires fewer sensors. This sort of power plant does not require any fuel. The key benefit of this sort of power plant is that it is renewable. Because sea water is constantly available and predictable, a large quantity of energy may be generated at any time. It's also really effective. The tidal power plant is particularly environmentally friendly because it does not need any fuel. It doesn't emit any greenhouse gases and isn't hazardous to the environment or the land.

3.7 Disadvantages:

Tidal power plants provide a number of benefits, but they also have certain drawbacks that must be considered. It is not detrimental to humans or the environment on land, but it poses a threat to sea life and the ocean ecology. Electricity transport equipment from the shore to the land is highly costly. Furthermore, for the building of the tidal plant, the attractiveness of the beach, as well as the residences and hotels adjacent to the beach, would be lost. As a result, the government would be unable to gain foreign cash from tourists, and many businesses will be forced to close. [36]

CHAPTER 4

COMPONENT OF TIDAL POWER PLANT

4.1 Component:

Because water returns to sea during low tides, tidal energy must be captured at high tide behind a dam or barrage and then used to drive a turbine linked to an electrical generator. The amount of energy accessible is proportional to the amplitude squared.

The main components of tidal power plants are:

- ✓ **Dam**
- ✓ **Sluiceways connect the basin to the sea, and vice versa.**
- ✓ **Power House**

The purpose of a dam is to create a barrier between the sea and the basin, or between one basin and the next if multiple basins exist. A tidal power plant is best described as a barrage. On a daily basis, barricades must endure waves with severe shock and pressure variations on both sides. A gate controls the flow of water via the sluiceways. They are prone to filling the basin during high water and draining the basin during low water. Vertical lift gates are utilized in existing factories. Gates with flaps also are utilized. Only the direction of the ocean to the basin is allowed through the flap gates. As a result, the basin's level increases. The power plant's primary components include auxiliary equipment, turbines, and generators. Because of the low head available, large turbines are employed. Turbines of the bulb and rim kinds are often utilized. Shaft turbines are also in a constant state of operation.

4.2 Classification of tidal power plant:

Tidal power plants can be classified on the basis of basins used in power generation:

- ✓ **Single Basin System.**
- ✓ **Double Basin System.**

4.2.1 Single Basin System:

Single basin system can generate power only intermittently. This is the most basic method of producing tidal energy. There is only one basin in the single basin design. A dam separates the basin from the sea (barrage, Dyke). To fill the basin, the sluice channel is opened during high tide. The turbine-generator units are housed within the barrage's ducts.

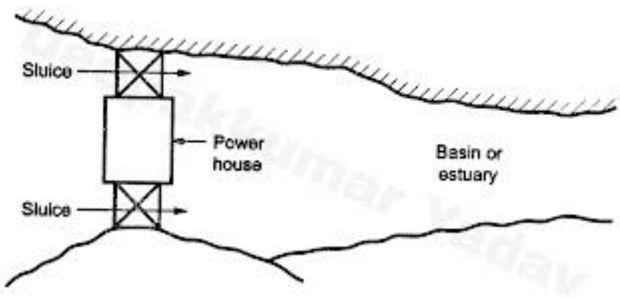


Fig.9: Single basin one way cycle system

4.2.2 Double Basin System:

There are two basins at different levels. A dam is provided between two basins. The dam is where the turbines are positioned. Sluice gates are built into the dam. The water level in one basin, the upper basin, is kept above that within the other, the low basin. Inlet gates for high-level basins and outlet gates for low-level basins are mentioned as inlet gates and outlet gates, respectively. The water level within the upper basin is high. The turbines are turned on when the water level in upper basin A creates a sufficient difference in head between the 2 basins. The electricity is made by the water flowing from basin A to basin B through the turbines. As a result, electricity generation and water filling in basin A proceed at an equivalent time. The water level in basin A reaches its maximum when the tide reaches its maximum value. The outflow sluices are opened when the rising level in lower basin B reaches an equivalent level because the receding tide. The outflow gates are closed when the tide reaches its lowest point. After a short time , the tide begins to rise. As a result, the water level in basin A begins to rise. the cycle continues.Two basin designs provide several advantages over conventional schemes, including the power to switch generation time with great flexibility and therefore the ability to get practically constantly. In most estuary environments, however, two basin designs are prohibitively expensive to create thanks to the extra expense of barrage length. However, there are several advantageous geographies that are well suited to this sort of strategy. [37]

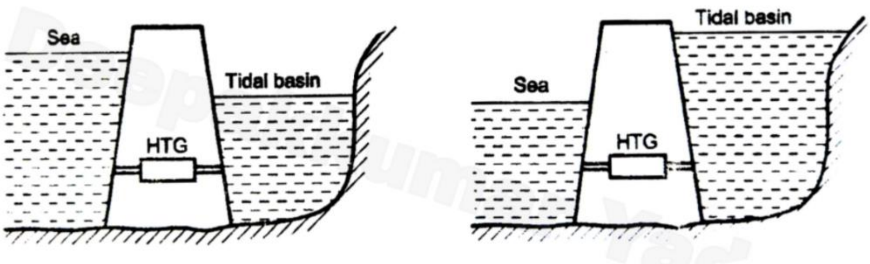


Fig.10: Double basin double way cycle system

CHAPTER 5

CURRENT & PREVIOUS STATUS OF TIDAL POWER

5.1 Current status and trend of tidal energy technology:

Technological advancement has led to the enhancement of the facility produced from the ocean. In 2019, the economy grew by 13%, which is significantly more than the previous three years' growth. However, in order for this technology to be in line with the Sustainable Development Scenario, it must be deployed quickly, necessitating annual growth of 23% until 2030. Research and development, as well as state policy, are essential to achieve the specified cost reduction and allow for broad deployment. In 2019, the quantity of electricity generated from marine sources increased by 13%. [38] Nonetheless, things of marine power remains "off track," since it falls in need of the Sustainable Development Scenario's (SDS) standards, which involve a 23 percent annual rate of growth through 2030. Several nations, including Canada, the uk , China, and Australia, have already got advanced maritime energy projects with capacities starting from 10 kW to 1 MW operational . [39] Nonetheless, such small-scale and demonstration enterprises are costly because they lack the economies of scale essential to be cost-effective. The extent of tidal power potential is decided by the ocean's rising and lowering waters. The influence production potential of neap and spring tides with a range of 4–12 m along the shore is 1–10 MW/km.

Current trends and prospects of tidal energy technology:

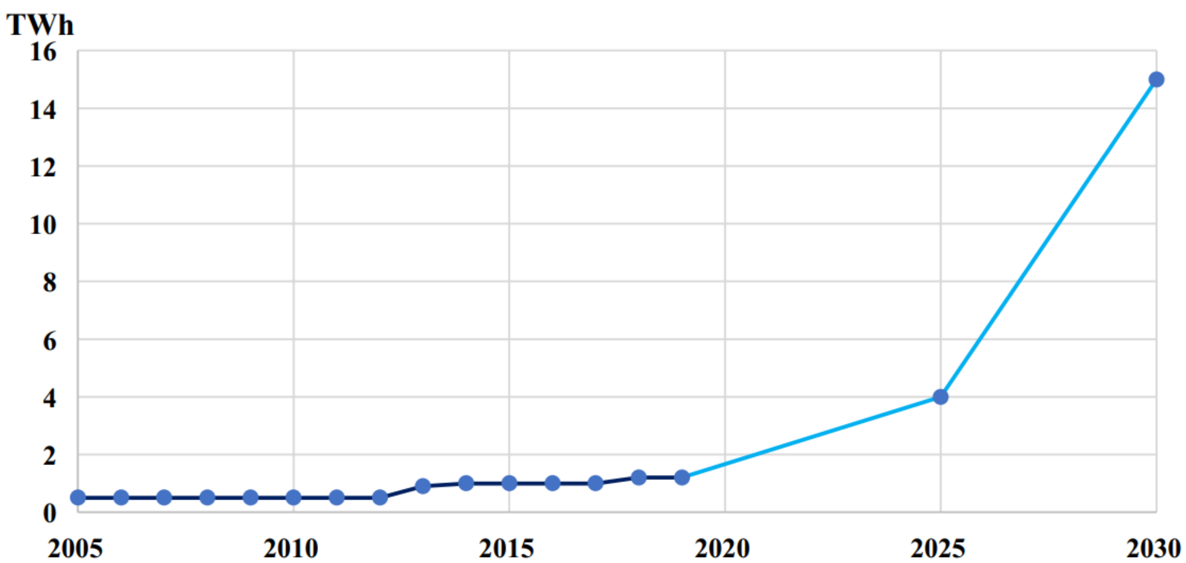


Fig.11: 3 Ocean power generation scenario, 2000–2030

Only a couple of tidal power plants within the world are currently generating electricity. it had been in Europe that the frst commercial tidal power station was installed. In 1920, UK became the frst country to suggest utilising the facility of the tides to supply electricity. However, the primary commercial tidal power station was inbuilt France, namely within the Rance Estuary in Brittany, in 1967. Estimated that this power plant , which had a capacity of 240 MW, could supply 4% of Brittany's residential electricity supply. [40] The plant's barrage was 720 meters long and covered 22 square kilometers. It acted as a road and was equipped with a lock to permit shipping to undergo . The barrage contained 24 reversible 10 MW bulb turbines and a pressure of 5 m. the facility plant had an annual output of about 480 GWh. [41] The Annapolis Royal Generating Station power station , which was built between 1980 and 1984 within the Bay of Fundy, Canada, is that the world's second biggest commercial tidal power station . This power station is additionally connected to the Canadian national grid, with a capacity of 20 MW. it's a 30 GWh yearly producing capacity, and it only has one Strafo turbine. The Russian government built the Kislaya Guba power plant within the Barents Sea in 1968, [44] with a capacity of 0.4 megawatts. it had been upgraded in 2006 to a 1.2 megawatt orthogonal turbine (Station). The Jiangxia Tidal power plant , located south of Hangzhou, was built by China in 1985. As shown in Table 1, it's a 3.2 MW generating capacity and a two-way operational capacity of 4.4 GWh of electric power annually (Plant). The (South) Korean Water Resources Corporation completed the world's largest tidal power facility in 2011. (K-water). This tidal power station features a capacity of 254 MW and may generate 552 GWh per annum . [42] South Korea began building of a second tidal power station in 2009, with a 1.5 MW installed capacity and therefore the ability to supply 2.4 GWh per annum (project). The Eastern Scheldt Barrier Tidal power station, with a generating capacity of 1.25 MW, was inbuilt Netherlands in 2015. This power plant has the capacity to supply electricity to about 1000 Dutch homes. [43] The specifics of the tidal power plants that are built thus far across the planet, the knowledge of the facility plants that are planned for future operation. The EU and its member states have mostly conducted research and development projects on maritime energy technologies in Europe. This research have resulted in advancements in available technology also as enhanced maritime energy legislation and planning methods. National and international governments must consider the effective construction of a marine energy marketplace that has provisions for incentives to stimulate the utilization of tidal energy and assist within the implementation of plans to enhance research and technology levels. Companies must even be encouraged to specialise in developing and installing ocean energy technology. [12]

5.2 Current status of tidal power in Bangladesh:

Bangladesh features a lengthy coastline which will be utilized for a spread of purposes. consistent with several recent studies, the coastline region is ideal for harvesting tidal power. The potential of tidal power in Bangladesh has been analyzed supported the capacity of power generation within the state's ocean and two basin areas. Because Bangladesh's rivers include sediment, the water level does not remain constant throughout the year, as the Bangladesh Inland Water Transport Authority's tide table demonstrates (BIWTA). Through several tide machines in various locations throughout the Bay of Bengal, the Department of Hydrography of the Chittagong Port Authority (CPA) and BIWTA in Bangladesh continuously record tidal data of the Bay of Bengal and two rivers [Karnaphuli of Chittagong and Possur of Khulna] basin area for the purpose of ship transportation, fishing, and territorial sovereignty consistent with CPA, in normal day conditions, the tidal speed or home in the Bay of Bengal is almost constant throughout the year.

For this reason, only two spots in the Bay of Bengal and another one in Possur Rriver of Khulna are considered:

- ✓ **Location-one: Basin of Possur River of Khulna.**
- ✓ **Location-two: Basin of Karnaphuli River.**
- ✓ **Location-three: Bay of Bengal.**

The basic tidal data collected by CPA and BIWTA is depicted on a map of Bangladesh:

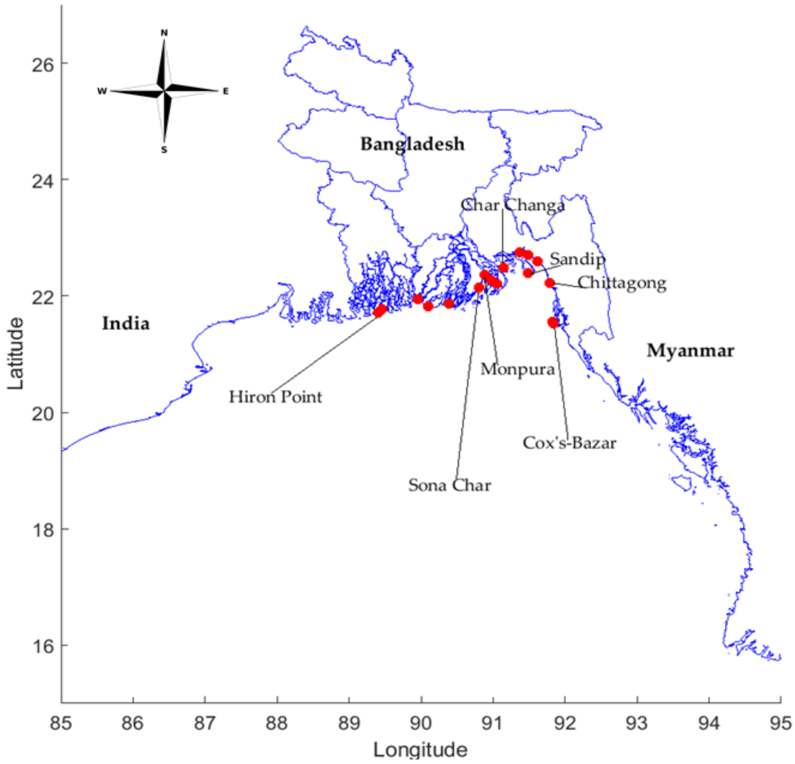


Fig.12: Survey Area shown in Bangladesh

The obtained tidal river data was examined for power production and shown through numerous graphs during this study. within the next sections, the chances of electricity generation per square meter area at various periods 9hour, day, and month) are illustrated. Location One [Possur basin in Khulna] the likelihood of electricity generation per hour per square meter area within the three different places of the Possur River from January to December 2016.

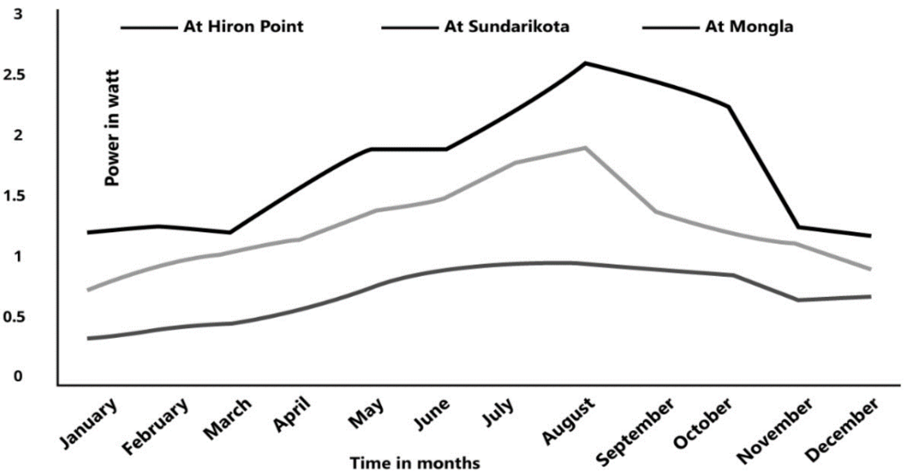


Fig.13: From January to December 2016, power production per month was measured at three locations along the Possur River Basin in Khulna (Hiron point, Sundari Kota, and Mongla).

The possibility of power production per hour per square meter area during a day of January-2017 is shown in Fig. 14:

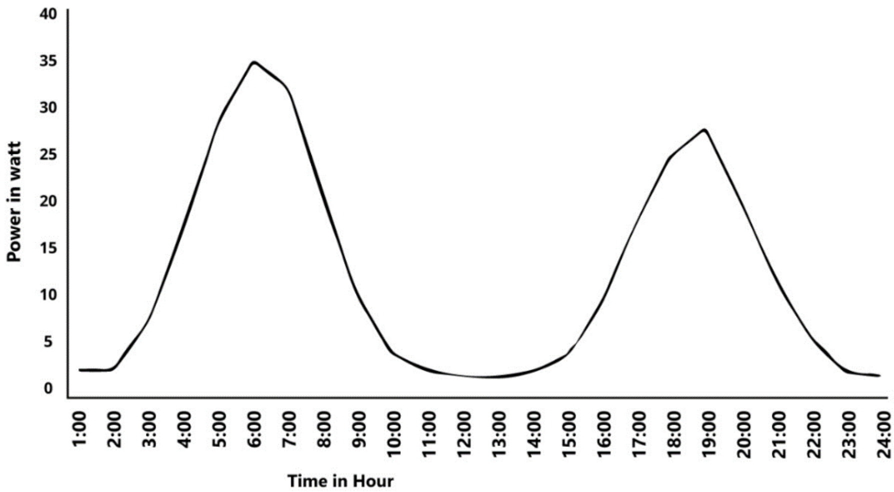


Fig.14: Possible Power Production per hour at Station Two in January-2017

The possibility of power production per hour per square meter area from January-2016 to June 2017 is shown in the Fig. 15:

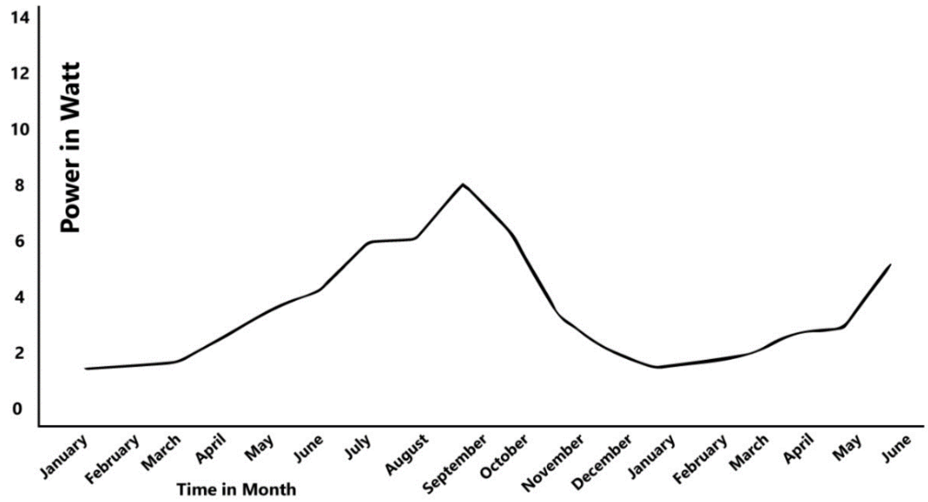


Fig.15: From January to June 2017, the potential monthly power production per square meter area at Location Two was calculated.

Station- Possibility of power production per hour per square meter area during a day of January-2016 is shown in Fig. 16:

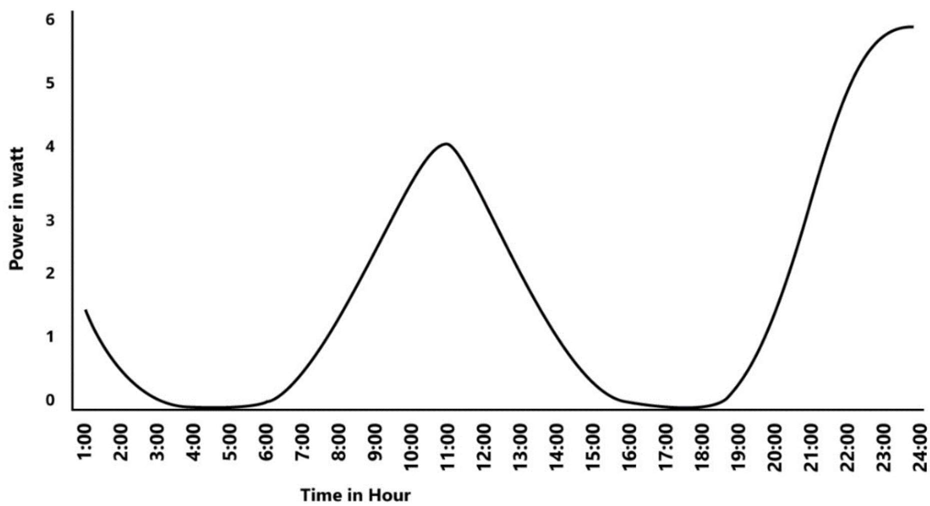


Fig.16: Possible Power Production per hour in a day at location Three in January-2016.

Possibility of power production per hour per square meter area January-2016 to June 2017 is shown in the Fig. 17:

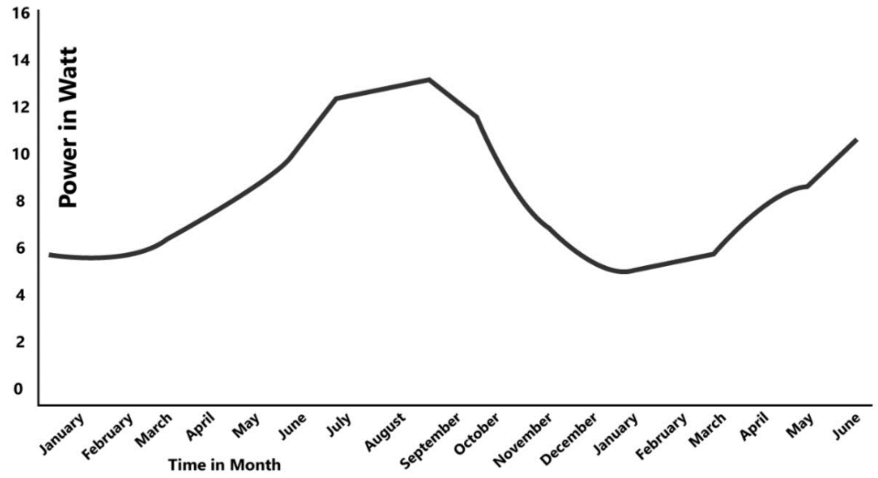


Fig. 17: From January 2016 to June 2017, possible power production per hour at Location Three.

Total average possible power production per square meter area from the above mentioned three locations for the year (January to December) 2016 is shown in the Fig. 18:

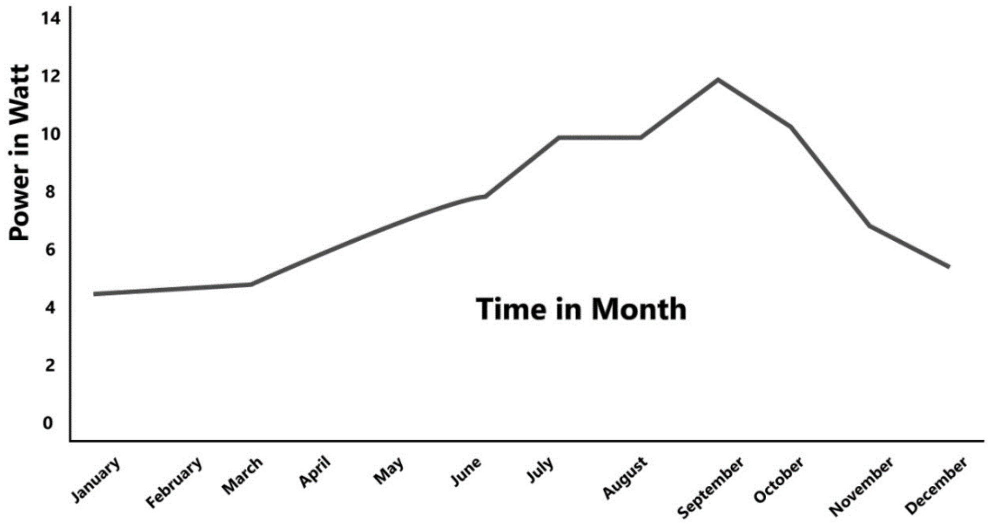


Fig. 18: Possible Average Power Production per month from Three locations from January to December 2016.

According to the above-mentioned numbers, electricity production is consistently growing and decreasing because the tides change. It reaches a high every six hours then drops to a minimum. this is often a tide-controlled power grid because the best and lowest power output are closely tied to the rising and falling of the tides. The potential for electricity generation per square metre of land in Bangladesh suggests that tidal power features a promising future. Because space isn't a problem in Bangladesh's Bay of Bengal location, it might be simple to create up variety of stream type devices, which could create a big amount of electricity when connected serial . It requires greater research into evaluations and economic viability. Finally, tidal power has the potential to play a crucial part in Bangladesh's national-grid power connection as a replacement source of renewable energy.

5.3 Environment view and ecological impact:

In recent years, the worldwide energy problem has been seen together of the foremost pressing challenges. Renewable energy (RE) is that the most vital energy source at this critical moment. [13] Tidal energy is that the most dependable energy source on the earth . The oceans and seas create enormous tidal movement and current twice each day and each day. When the lunar and solar high tides are in phase, the tidal ranges are highest, and once they are out of phase, the tidal ranges are shortest. Tidal power has the potential to scale back pollution while also providing economic benefits. Oceans encompass 70% of the surface , and tidal movement is very large . within the Maheshkhali canal, Bangladesh has the geographical potential to develop a tidal power station . [14] Karnofuli Hydro power station , with a producing capacity of 230MW, is Bangladesh's sole hydro power station . [45] Moheshkhali may be a beautiful island off the coast of Cox's Bazar, within the Bay of Bangle. Between Moheshkhali Island and Cox's Bazar, there's an almost 15-kilometer-long canal.[46]

The channel is shown in below in Fig. 17:

[47]

Although Bangladesh's government has prioritized the utilization of renewable energy, there's currently no tidal generating within the country. In Bangladesh, tidal power generation employing a tidal barrage powered by a low-head water turbine could be a far better option. consistent with tidal statistics published by the Chittagong Port Authority, the typical head of high water during this canal is 3.83m above mean water level (MSL) (CPA). [48] The monthly average electricity generation determined from the resource and generation model is shown in Table I, with the highest 206 MW power commonly generated in August and a total of 115.73932 MkWh (Million-kilowatt hour) energy frequently generated throughout the year. [49]

Monthly possible generation capacity below in table 9:

Month	***Power Output (MW)***	***Energy (MkWh)***
January	141	7.377
February	143	6.3636
March	147	8.89
April	167	9.415
May	197	10.45062
June	199	10.693
July	106	13.765
August	208	12.1337
September	199	9.6467
October	195	10.8965
November	157	8.8178
December	161	7.304
Total		**115.75**

According to the Annual Report of the Power Grid Company of Bangladesh (PGCB), Bangladesh's annual net energy generation in 2015-2016 was 27646 MkWh, and the calculated energy generation from this proposed project is 115.73932 MkWh, or 0.42 percent of overall energy generation in 2015-2016. [50]

5.4 Cost Management and Estimating:

Economic assistance is out there from a spread of monetary entities that aid within the development of a sustainable energy system, like the planet Bank Climate Investment, Adaptation, and Least Developed Countries Funds. [17] Furthermore, the Clean Development Mechanism and Carbon Finance, both internationally recognized methods, provide the choice to boost money for any sustainable development initiative. the main goals of the organizations described above are to scale back gas emissions and to form poorer populations in developing countries less susceptible to the negative effects of global climate change by supporting green energy technologies and sustainable development. Bangladesh has been designated as a most vulnerable nation within the COP15 meeting, also as a developing country that's suffering the foremost from global climate change . As a result, the tidal power project in Sandwip are going to be beneficial to the country and can get support from all of the aforementioned organizations. [18]

5.5 Prospects of tidal energy and proposed power plant:

There are many estimations for the entire energy available worldwide from tides. consistent with the technically harvestable tidal energy resource from areas on the brink of the coast, "is estimated by several sources at 1 terawatt (TW)". However, with capacity factors above unity, a possible worldwide ocean tidal energy resource of 90 gigawatts (GW) predicts a yearly output of 800 TWh (a producing power of 90 GW generates at the utmost 9036524= 788,400 GWh or 788.4 TWh). [19] Tidal dams or barrages are currently recognized as deterministic energy technologies capable of produce power on an outsized scale. the bulk of tidal energy research and development is concentrated on tidal barriers and turbines. subsequent epoch is probably going to witness the tidal energy becoming a totally profitably sustainable energy source, and thus comprehensive research is significant in tidal energy. [51] so as to make tidal river energy projects, large amounts of capital finance are now available. the value of generating power from tidal energy is substantially above that of traditional energy source. Furthermore, there are concerns about the long-term environmental effects of tidal energy equipment installation and operation on marine life and birds. Because the technology has only been around for around half a century, the longer term appears brighter because of the designs of tidal dams or barrages. Nonetheless, it's been said that there are substantial proposals for tidal barrage projects in Russia, Korea, India, and therefore the uk , totaling approximately 115 GW, and deployment forecasts for tidal energy up to 2020 are almost 200 MW. [52]

The proposed tidal power stations across the planet . Though there are certain hurdles in its development and promotion of data of ocean energy resources, tidal energy has the power to make power and enhance their current potential. the event of tidal energy faces variety of challenges. More study might reveal these obstacles, and governments, oceanic and maritime services, industry, research organizations, and colleges will get to develop an integrated and coordinated technique so as to realize a strong, practical, and cost-effective tidal energy. Increasing affordability, on the opposite hand, may move innovation, incentive, and price reduction to other energy sources. [53]

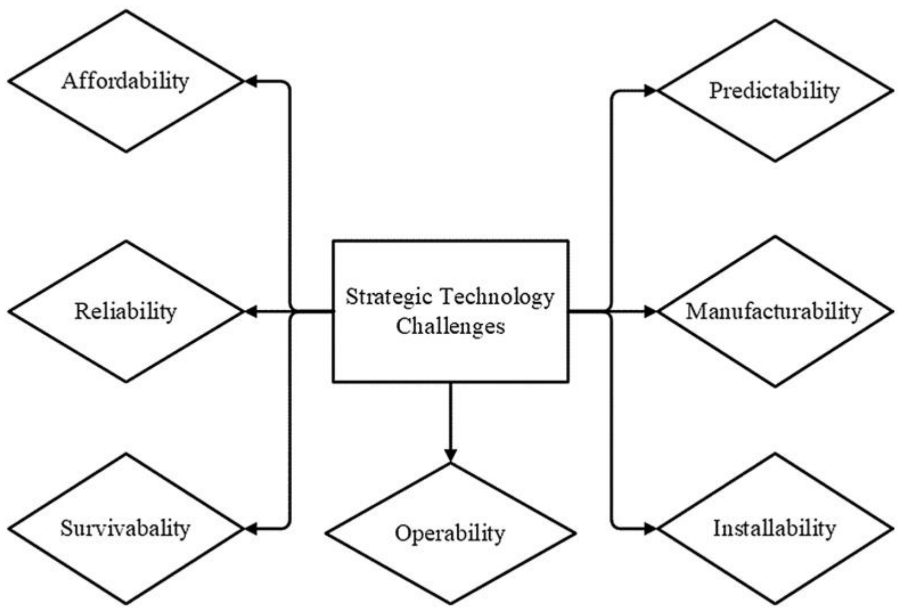


Fig.18: Challenges in the development of tidal energy.

The difficulty of evaluating the consequences of turbulence and their influence on the component's fatigue life has been highlighted by predictability. As a result, conducting more comprehensive studies on factors such as specific components of the MTBF (mean time between failure) as well as life expectations, and developing the manufacturability of tidal energy converters from small-scale prototype to large-scale production could help reduce unforeseen conservation requirements. this may have an impression on the planning of key modules and sub-elements, also because the extension of the assembly process. [54] additionally , research into novel materials as steel substitutes reveals significant cost savings also as a discount within the size of existing modules. the event of novel regulating techniques, also as operating and testing procedures, will aid within the long-term survival and operability of tidal energy technology that operate in harsh environments. Providing low-cost automation technologies that require less human interaction would allow low-cost multipurpose ships to exchange high-cost special vessels, reducing setup and maintenance costs.

CHAPTER 6

FUTURE PREDICTION

6.1 Historical Background:

The practice of harnessing ocean energy dates back to the late 1800s. In 1799, Monsieur Girard got the primary patent for wave energy conversion. The patented gadget was a ship linked to the coast that used waves to power pumps and other gear. Between 1800 and therefore the late 1960s, there have been just a couple of attempts to capture the ocean's energy. The world's first and second large-scale tidal power plants, however, were inbuilt 1966 within the Rance River's estuary in St. Malo, France. This ocean tidal power plant remains operational today, generating 240MWh of electricity annually. [55] On Lake Sihwa in South Korea , the world's largest tidal power plant , with a capacity of 254MW, is found . Swansea Bay Tidal Lagoon within the uk (240MW), MeyGen tidal energy project in Scotland (86MW), Annapolis Royal Generating Station in Canada (20MW), et al. are tidal power stations. [56]

6.2 Conception:

The huge extent of the seas, tidal power offers immense promise for future power generation, and if there is one thing we can reliably forecast and be sure of on this planet, it is the coming and going of the tide. This is a considerable benefit over other sources, like as wind and solar, which are less predictable and reliable. For the gravitational pull of the moon and sun, as well as the rotation of the earth, tides come and go. The sun and moon's gravitational forces on the spinning planet cause the ocean's water to swell higher, causing tides with two high tides every 24 hours and 50 minutes; Every upward and downward movement stores a big quantity of P.E. . The energy of the tides springs from the earth's rotating energy. Through the utilization of tidal generators, this energy could also be wont to create power. Large underwater turbines are positioned in places with strong tidal movements and are meant to capture the kinetic action of ebbing and surging ocean tides so as to get energy. [57]

The tidal energy (potential energy) available in a volume of water is:

$$\boldsymbol{E = \frac{1}{2} Apgh^2}$$

Here,

The vertical tidal range is denoted by h.

The horizontal area of the barrage basin is denoted by the letter A.

ρ is the density of water = 1025 kg per cubic meter.

The acceleration due to gravity on Earth is g, which equals 9.81 meters per second squared.

The hydraulic head above the dam decreases as the basin empties via the turbines, resulting in a factor of half. The maximum head is only attainable when the water level in the basin is low, assuming the high water level is still there. This tidal energy is sufficient to drive the turbine, which generates electricity. Energy is generated from tides in a similar fashion to hydroelectricity, with the exception that water can flow in both directions during the tide and ebb, and electricity is generated using two-way turbines. The system is referred to as a two-way tidal power generation system. There is also a technique known as one-way tidal power generating, which uses a single one-way turbine.

Whole process of tidal power generation is shown below:

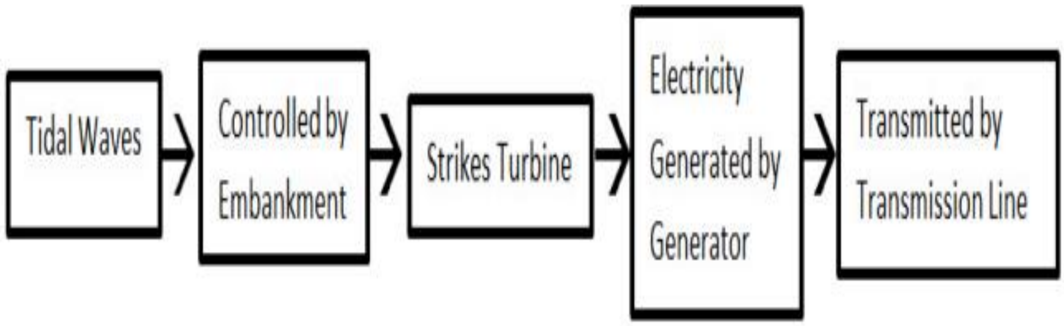


Fig.19: flow diagram of tidal power generation. *[10]*

6.3 Tidal power prospects in coastal Bangladesh:

Bangladesh may be a country with low power usage (95 kw/hr per capita) and a big demand for development along its coastline. Only 16 percent of the population is already electrified, with fewer than 5% having access to electricity in rural areas. Bangladesh has one among rock bottom electrification rates within the world. Bangladesh features a lengthy (710 km) coastline with a tide height/head rise and fall of 28 meters. Because the barrages required for providing regulated flow via turbines also are required for control , the potential for tidal power to be harnessed is substantial. the matter of huge capital costs is avoided because the engineering is either already in situ or is required for cyclone protection. consistent with the subsequent two tables, Bangladesh has excellent tidal energy opportunities, notably at Sawndip. Sawndip may be a small island within the Bay of Bengal, on the brink of Chittagong and only 15 kilometers from the mainland. On a neighborhood of 240 km2, the population is estimated to be approximately 330,000. The Ganges delta has formed a mudflat that covers the entire island. the chief Agencies paid a scoping visit at Sawndip in late November 1999.the agricultural Electrification Board and Grameen Shakti of Bangladesh aided the International Centre for Application of solar power and Tidal Energy Australia (TEA). This island isn't a well-liked tourist destination, and Bangladeshis rarely visit. Sawndip's 5 m tides make it difficult to access the island, which is permanently encircled by mud flats unless at high tides. Cyclones frequently flood the island, and over thousand people drowned there in 1991. A control barrier with 28 sluice gates surrounds the entire island. there's also a little energy system that connects the island's main business sectors. Two 200 KW diesel generators provide energy for a couple of hours within the late afternoon/early evening, primarily for business usage. Rice threshers are powered by batteries in some houses and diesel generators in others. within the clinic, a photovoltaic (PV) system is used to stay a vaccine cooler running. The mud flats have highly rich soil, making it possible to cultivate a good range of food crops. Rice is exported, and therefore the island is usually self-sufficient in vegetables and fruits. Although shrimps are harvested from the mud flats, there's no aquaculture on the island. there's no power in any of the island's schools or universities, and therefore the island's job options are restricted. supported a scoping visit and professional examination of several tidal ranges.

Bangladesh may harness energy from coastal tidal resources by applying two technologies:

- ✓ **Low head tidal movements (2~5 m head).**
- ✓ **Medium head tidal movements (> 5 m head).** [7]

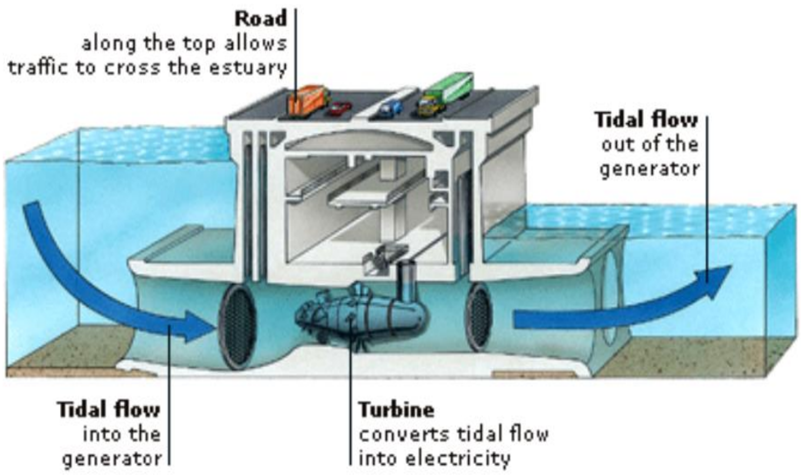
6.4 Tidal energy prospect in Bangladesh:

Bangladesh is located between the latitudes of 20O34" and 26038" north and the longitudes of 88001" and 92041" east. The nation boasts a 724-kilometer-long coastline and several tiny islands in the Bay of Bengal, where powerful tides and waves are always present. This lengthy shoreline with high waves could be an incredible source of electricity. The tides in Chittagong, Bangladesh's south-east, are generally semidiurnal, with a good fluctuation in range that corresponds to the seasons, with the most important occurring during the south-west monsoon. During the season, the daytime tides are smaller than the nighttime tides, and the other way around during the season, thanks to a high diurnal impact on the tides. Bangladesh is experiencing a severe electricity shortage. it's attempting to resolve the difficulty of high-cost leasing power plants. Renewable energy is increasing popularity at this point and helps to alleviate the energy dilemma. Bangladesh is additionally seeking for a long-term solution to the matter within the sort of a atomic power plant. the utilization of fossil fuels for electricity generation adds to heating, necessitating a shift focused to alternate energy sources. Furthermore, the discharge of CO_2 into the atmosphere caused by the combustion of fossil fuels contributes to heating. Despite this, oil accounts for the bulk of worldwide energy usage. Oil prices are on the increase. Oil, gas, coal, and other world resources also are expected to run call at subsequent 40 years. Tidal power is one among the energy sources that has been disregarded. an outsized quantity of power could also be generated by the tide. The ocean spans 75% of the surface and has huge potential for electrical generation.

it's been calculated that if but 1% of entire tidal power capacity is generated, it'll cover five times the entire world demand. To be a viable choice for brand spanking new capacity builders, a suitable power generation technology must be mechanically sound, ecologically acceptable, and economically feasible. Tidal power, for instance, accounts for just 2.5 percent of worldwide energy use. Tidal power could also be wont to generate energy during a sort of ways. the event of tidal barrages is one among the ways many tidal power plants harvest electricity. A barrage may be a dam that's powered which is that the height difference between high and low tides. A dam's tunnel allows water to flow through it, turning turbines that make energy. There are various drawbacks to using tidal power. The usage of a tidal barrage can have a big environmental impact. Barricades prevent navigation, obstruct fish migration, and alter the dimensions and position of the intertidal zone. The regions that alternate between wet and dry during tide cycles are referred to as the intertidal zone. With the event of barrages, several plants and fauna that sleep in the intertidal zone will go extinct. Furthermore, when there are ebbs and tides, barrages can only generate electricity for up to 10 hours a day. Barrage power plants have lost favor thanks to several drawbacks, and tidal river power plants, which have a lower environmental effect, are now favored. [20]

6.5 Future Aspects of Tidal energy:

In terms of the financial aspect, the longer building time for bigger systems combined with low load factors would end in high work unit prices. as compared to most other sorts of power plants, tidal projects have a relatively high cost of capital in reference to the useful output. As a result, the capital payback period is longer, and therefore the rates of return on invested capital are poor. As a result, predicted unit costs of generation are unlikely to enhance, and that they remain uncompetitive with traditional fossil-fuel alternatives for the nonce. The aspect of tidal power production with an economical solution is represented by the feasible low-impact installations.



However, the development of tidal energy would result in certain non-energy advantages, which would have a relatively low monetary worth in comparison to the entire system cost. These advantages are difficult to quantify precisely, and they may not always favor the barrage developer. At the height of construction, there would be a large number of job openings with some permanent long-term jobs created as a result of the accompanying area economic growth.

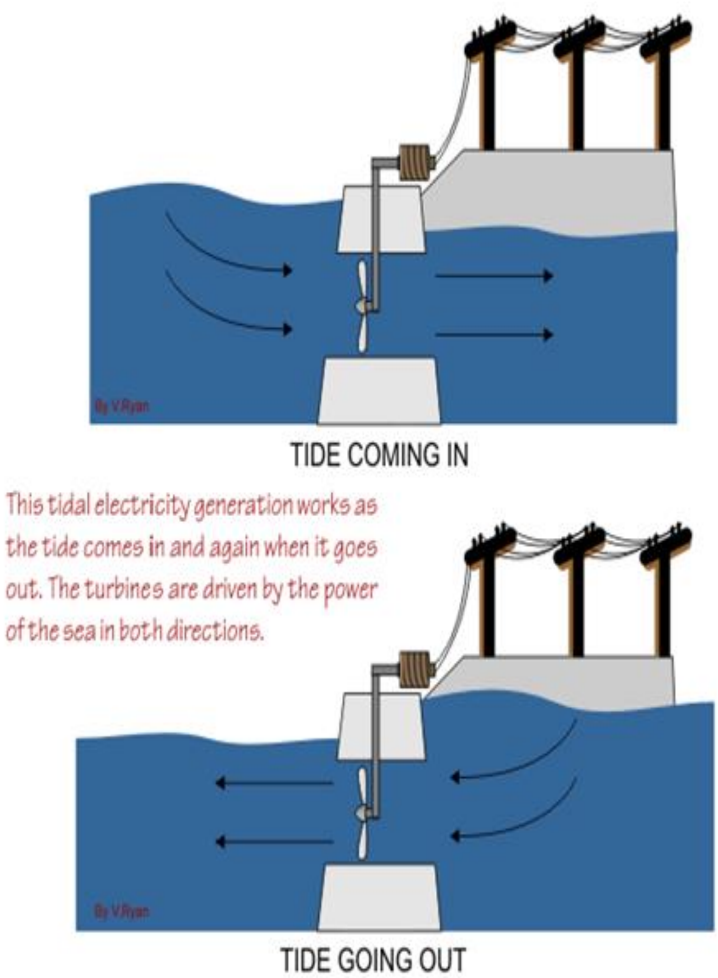


Fig.20: Tidal Electricity Generation Feature Using

The public's attention is increasingly focused on these non-energy benefits, which is an important issue for the growth of tidal power generation. [20]

CHAPTER 7
RESULT AND DISCUSSION

Although there is no tidal power station in Bangladesh, a search has recently been conducted to investigate the feasibility of tidal power generation that is suitable for the Bangladeshi environment. Totally in Bangladesh some places are suitable for tidal power station and this paper is that the continuation of that research. The previous work didn't perform some issues. Here during this paper we shows this scenario of tidal power, tidal energy and tidal power generation in our Bangladesh. This paper performs a review paper for all knowledge of tidal paper we bring out generation of tidal energy, its classification and its working rule . Also added present scenario tidal power in Bangladesh. Then next chapter we added about tidal power generation and its method capacity value and possibilities of tidal power generation. We discussed about component of tidal power station energy generation and its environment and ecological impact and also its future prediction and aspects in Bangladesh. For an accurate determination of tidal power analysis of knowledge few years of the few places of stations are finished computing tidal constituents. results of this analysis we collected some data table. These data are help to seek out which place are suitable for establish tidal power station of Bangladesh. Current Status and power generation are helpful to seek out better place to create tidal powerplant in Bangladesh. We collected gauge data of cox's Bazar and Mongla gauge station for the amount of spring and near tides using those data we collected tidal ranges and people results are show in appendices. This ranges are help to seek out better place for build tidal power station.

CHAPTER 8
CONCLUSION

The country features a great challenge within the upcoming days due to unsustainable energy sources. With the increasing power demand in Bangladesh. there's no substantial decide to meet the upcoming power crisis by renewable energy. During this time, tidal power has proven to be a profitable renewable energy source. Furthermore, tidal power can create a total of 53.19 MW from various locations across the country, but no meaningful attempt is currently being made to supply power from this source. The proposed tidal power plant has the potential to help reduce load shedding. Furthermore, through enhancing transportation between Cox's Bazar and Moheskhali Island, this project will provide greater socio-economic benefits to local residents. Tidal current are certainly promising, these technologies are very far away from being an answer for today’s energy problems, as they have significant further research and development and therefore the solution to several challenges. This paper presented the entire reviewed about tidal power energy and generation in Bangladesh.

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